HOW TO KEEP WELL

A TEXT-BOOK OF PHYSIOLOGY AND HYGIENE FOR THE LOWER GRADES OF SCHOOLS

BY

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PREFACE TO REVISED EDITION

Owing to a demand for a revision of this book the author has undertaken to rewrite, rearrange, and illustrate its several chapters in harmony with the latest ideas of teaching this branch of study. In this edition, as in previous editions, the author has aimed to present clearly and tersely the simplest facts concerning our bodily life.

The author believes that instruction in physiology is of little value to pupils in the lower grades of our schools merely as a scientific study. It is of profit only so far as a text-book for these grades is a means to enable young boys and girls to understand the simple laws of health and apply them intelligently to their daily living; yet if they are to understand even the plainest rules of health they need to know something about the structure and use of the various parts of "the house we live in." To this end a few facts about anatomy and physiology have been presented in each chapter.

To make the book more attractive and interesting to the young student, the author has used a familiar style, weaving into the text such incidental matter as may serve to arouse the interest and maintain the attention of young pupils.

In this edition, as in other editions, a series of carefully graded and practical experiments has been added to the text of the

various chapters. These experiments are simple and may be performed with inexpensive apparatus.

This book complies with the laws of those states which require in their public schools the study of the nature and effect of alcohol, tobacco, and other narcotics upon the human system.

The author would acknowledge his indebtedness to Dr. Margaret B. Wilson, of the New York Normal College, for helpful suggestions and criticisms in the preparation of his manuscript for the press.

A. F. BLAISDELL.

WINCHESTER, MASS.,
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HOW TO KEEP WELL

CHAPTER I

INTRODUCTION

1. The Study of our Bodies. — Our bodies are always busy. We move about and are warm. We eat, drink, and work. We feel, hear, see, think, talk, and breathe. We do not often wonder about these things, simply because they are so common. When we do stop to think about them we realize how wonderful it is to live and keep in good health.

What study could be more important, more interesting, or more fascinating than that of our own bodies! We may well wonder at the marvelous work of some delicate machine, for it seems as if it were really alive; but when we study the human body we find it not simply a most perfect machine, but one actually endowed with life, — a mind, a soul.

2. Questions which appeal to Thoughtful Pupils. — The study of our own bodies often suggests many interesting questions, which should be of personal interest to every thoughtful pupil. How do we move from one place to

another? Why are we hungry? Why do we eat food and drink water? What happens to the food after we swallow it? Why are we warm even on the coldest day of midwinter?

All these questions, and many more, this little book will try to answer. There will not be room to tell you all about the wonders of our bodies, but you can learn something of the story. There is, of course, much more to learn. When you know all that there is in this book you will be so interested, we hope, that you may wish to give further study to this same subject.

3. How the Body may be compared to an Engine. — Our bodies are in several ways like a steam engine. The food is to the body what coal, wood, or other fuel is to the engine. Neither the body nor the engine can do its work without food or fuel, and plenty of air besides.

The engine may be said to feed on its fuel. It gets rid of its waste in the form of clinkers and ashes. The body, as you will learn later, gets rid of its waste by the breath, by the sweat, and in other ways.

The engine will not do its work well unless all of its parts are kept in working order. So it is with our bodies. Each and every part must be used in its proper way and be kept neat and clean, both inside and outside.

Every part of an engine depends upon some other part. Thus if the rods and joints are not well rubbed and oiled, the wheels will not turn easily. So it is with

the body. Every part depends for its well-being upon some other part. Even when we are hungry, bad news may take away the appetite. If the heart is out of order, although every other part of the body may seem well, we soon become ill and perhaps may die.

4. How the Body is unlike an Engine. — If we think for a moment, we shall see that the body is unlike an engine in several ways. The fuel of an engine is burnt in the fire box, a separate part of the machine set apart for this purpose. Our food is burnt, or oxidized as it is called, bit by bit in nearly every part of the body. Unlike the fuel of the engine, which burns quickly with a bright light, our food burns gently and slowly without giving out any light.

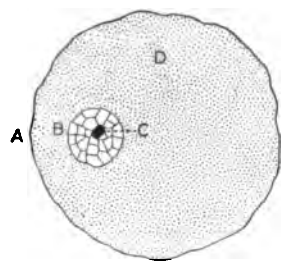

Fig. 1. — Diagram of a Cell

A, cell wall; *B*, nucleus; *C*, dark spot known as a nucleolus; *D*, mass of jellylike substance known as protoplasm or living matter

Unlike a machine, the body grows. Think how quickly the helpless child becomes a stout boy, and then a strong man! The engine is always wearing out. If it works badly now and then, it must be stopped, taken apart, and repaired. That is, the engine cannot mend or repair itself.

The body, too, is always wearing out; but, unlike the engine, it can repair itself while it is at work. Of course our bodies cannot remake themselves in all ways. If

the lobster loses a claw, another will grow, and after a time be as good as the lost one. But if we lose an arm or a leg, kind Nature will not give us another limb.

5. The Story told by the Microscope. — If we examine with a high-power microscope a tiny bit of the body, we find that it is made up of a countless number of particles composed of a jellylike material, each having within itself the power to live and grow. These tiny particles of living material are called **cells.**

Now all the material of our bodies, and also that of every living thing, whether plants or animals, is made up either of living cells or of things which these cells have made. The strong man, the huge elephant, the giant oak, the smallest insect, and the dainty wild flower, — each began life as a little cell.

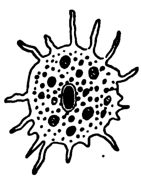

FIG. 2. — Diagram of an Amœba Cell

The amœba is a tiny creature found in water which contains decaying matter

These cells are arranged by groups into many kinds of tissues and organs. The cells of each tissue or organ have a special structure which enables them to do their own distinct work in our bodily life.

Thus we shall learn later that certain cells become muscles which move the body. Other cells form the hard material of bones and the soft, pulpy substance of the brain. There are other cells, as those of the liver, the lungs, and the kidneys, whose duty it is to rid the body of waste matters.

6. Some Hard Words explained. — Before we begin the study of the more interesting parts of this book we have to do something like cracking the shell of a nut to get at its kernel. We need to learn the meaning of a few hard words.

Before we can tell how plants and animals live we must know what plants and animals are. A watch-maker could not understand the working of a watch unless he first learned something about its various parts. So it is with the study of our bodies. We must learn a few simple things about their structure before we can understand the manner in which the various parts do their work.

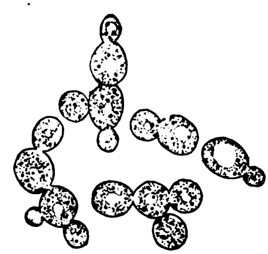

FIG. 3.—Cells found in the Juice of Apples

For instance, in each of the following chapters we shall try to learn about the different parts of the body, what and where they are, and how they look. This is called **anatomy**.

Again, after we have studied a few things about the different parts of the body, we need to learn about the uses of these parts. This is called **physiology**.

Now, after we have studied the structure and the uses of various parts of the body, we ought to learn how to take care of them and keep them in health. This is called **hygiene**, or the study which tells us how to keep well.

7. Tissues and Organs. — The countless myriads of cells in our bodies are arranged in groups, each consisting of similar cells which have a special structure quite different from that of other cells. These groups of similar cells are known as **tissues.**

The body is thus made up of tissues such as flesh or muscle, bone, nervous tissue, and so on. Some of the tissues hold together and help support various parts of the body. Other tissues make up other parts which have a special work to carry out. These parts are called **organs.**

Thus the stomach is an organ of digestion, the eye of sight, and the lungs of breathing. Each of these organs is made up of a number of different tissues.

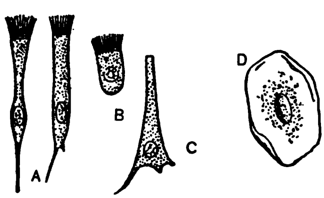

FIG. 4. — Various Kinds of Cells

A, cells from the intestines; *B*, cell from a dog's mouth; *C*, cell from the inner surface of the windpipe; *D*, cell from the lining of the mouth, seen on its broad surface

8. Why the Care of our Health is a Duty. — We ought to keep ourselves in good health as far as we are able, that we may do well what we have to do in life, and be useful to others, and not become a burden to them. Few people can be happy or very useful if they are not well.

Everybody has some work to do in the world; nobody can afford to be idle. Some have to work with their hands, others with their heads; but all work can be

done best only when the body and mind are healthy. To keep ourselves alive, we must have two things,—food and air. But to keep ourselves well and strong, the food must be of the right sort, and the air must be pure; we must be cleanly and temperate; we must have plenty of exercise in the day-time, and plenty of sleep at night.

If we know the uses of the different parts of our bodies, we shall understand better how to keep them in good order,—just as a boy can take better care of his bicycle if he understands the uses of its different parts.

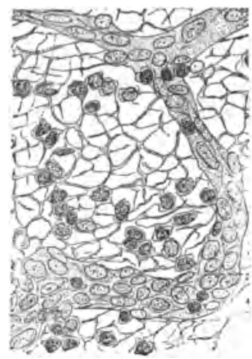

FIG. 5.—Cells from a Lymphatic Gland, showing the Fine Network of Connective or Supporting Tissue

We cannot be ill without giving trouble to those with whom we live, and causing them expense and loss of time. We may not be able to prevent all sickness and disease, but a great deal can be prevented when we learn to take good care of ourselves.

Boys and girls may learn many things about the wonderful structure of the body and how to take better care of its various parts. When they grow older they can learn more; and the more they learn the more they will see that it is a duty they owe both to themselves and to others to do all in their power to keep well.

QUESTIONS FOR REVIEW

1. Why do we not wonder about the things we notice and read about our bodies?

2. What do we realize if we stop to think about these things?

3. What can you say about the importance of this study of our bodies?

4. What are some of the questions which should appeal to every thoughtful person?

5. Where do we have an opportunity to learn the answers to some of these questions?

6. Describe in some detail how the body may be compared to an engine.

7. How will you show that the body is unlike an engine?

8. What do we find if a tiny bit of the body is examined with a microscope?

9. Of what are living plants and animals made up?

10. How are the cells of the body arranged?

11. Before we begin to study this book what is necessary to be learned in order to understand the subject?

12. What is the first thing to be learned about plants and animals?

13. How may you illustrate this point by what a skillful watch-maker must do?

14. What is meant by the word anatomy?

15. What do you mean by the word physiology?

16. How will you explain the use of the word hygiene?

17. Can you illustrate the meaning of the words anatomy, physiology, and hygiene by taking the stomach or the eye for an illustration?

18. Explain how the countless cells of the body are arranged into groups.

19. Give illustrations to show how the body is made up of various tissues.

20. Explain in some detail how the care of our health should be a duty.

CHAPTER II

THE FRAMEWORK OF THE BODY

9. The Bony Framework. — The bones are the framework of the body. They are to the body what timbers are to a house, or ribs to a vessel. They may be compared to the framework of an engine.

The brain is like the engineer who directs all. When the engineer moves a lever the steam puts the machinery in motion. When we wish to move, a message is sent from the brain along the nerves to the muscles. The muscles pull upon the bones and move the limbs.

10. The Use of the Bones. — The bones are something more than a framework. They serve other useful purposes; one is to protect the soft parts of the body. Thus the bones of the skull inclose the delicate brain, and the ribs form a barrel-shaped cage of bones which protects the heart and the lungs.

Grooves and canals in the solid bone shelter tiny blood vessels and delicate nerves. There are little knobs, grooves, and sharp edges upon the surfaces of many bones, to which muscles and ligaments are fastened.

11. The Number of Bones. — How many bones have we in our bodies? Let me tell you. There are about two

hundred in all. They are of various sizes and shapes. Every bone has its name and is fully described in larger books which you may wish to study some day.

Experiment. — The mineral or earthy part of bone may be readily shown by putting a portion of a beef soup bone on the hot, clear fire of a kitchen stove until it is at a white heat. The animal matter is soon burnt out, leaving the white, earthy part, which readily crumbles. The bone must be watched lest it burn too long and crumble into pieces. Every outline of it is seen if it is removed from the fire with care and allowed to cool.

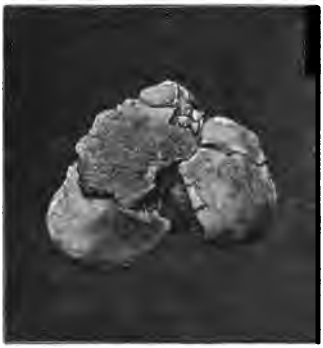

FIG. 6. — End of a Beef Bone burnt as suggested in Experiment

(From a photograph of work done by a pupil at home)

12. The Composition of Bone. — Bones are very hard and strong. On handling a piece of hard bone we would scarcely believe that there is any soft matter in it. In reality every bone is composed of a soft, jellylike substance, or **animal** matter, and a hard substance, or **earthy** matter, made up largely of the mineral known as lime.

Perhaps you have seen the jelly that is made when a calf's foot or a beef bone is boiled for a long time. This is some of the animal matter which has been separated from the earthy matter by boiling.

In childhood the bones have a larger proportion of animal matter than they contain in adult life, while in old age they have more lime. Hence the bones of

children often bend rather than break in the many tumbles with which they meet.

The bones of an old person are brittle compared with those of a child. Thus it is that the bones of old people are more easily broken and are often difficult to reset.

The bones are elastic. The Arab children, it is said, make excellent bows from the ribs of camels.

Experiment. — A simple experiment may show the animal part of bone. Any long, slender bone, like a chicken's or lamb's leg bone, may be used. Obtain the bone at the market; scrape and clean it. Fill a quart glass fruit jar nearly full of water, adding a cupful of muriatic acid. Soak the bone in the acid mixture for a few days. The earthy matter is slowly dissolved, leaving the bone in its form, but so soft and flexible that it can be readily cut and bent.

FIG. 7. — Showing how the Small Bone of a Sheep's Leg may be bent after its Earthy Matter has been soaked in an Acid Mixture as described in Experiment

(From a photograph of work done by a pupil in the schoolroom)

The power of bone to resist decay is remarkable. Bones have been dug from the earth which have withstood decay for many hundreds of years.

13. General Make-up of Bones. — If we take a long bone, like that from a sheep's leg, or even one end of a beef bone, and saw it lengthwise, we see that the ends are soft and spongy, while the rest is very hard.

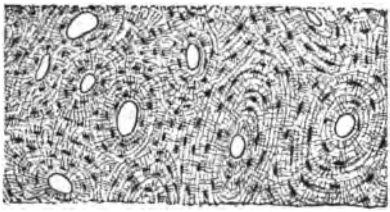

FIG. 8.—How a Thin Section of Dry Bone appears when it is examined with the Microscope

We all know that it is quite easy to crunch with our teeth the large end of a chicken's leg bone, and that it is often very difficult to dent the middle part. Some bones are hollow inside and filled with a soft oily substance called **marrow.** This gives a certain flavor and richness to soup. Crush one end of a bone and hold it over a hot fire. The heat will soon melt the marrow, which will sputter and burn like tallow. The marrow is the life of the bone. The Bible tells us that the "bones are moistened with marrow."

FIG. 9.—Teaching the Bones in the Schoolroom

The teacher is showing her pupils the appearance of the hard and spongy structure of bone, with the aid of a thigh bone which has been sawed for this purpose by the market man

(From a photograph taken in the class room)

14. More about Bones.—The bones of some animals, like lobsters, are, as you know, on the outside in the form of a shell. All our bones are inside, and are covered with flesh and fat; over all is the skin.

While we do not cast off our bony framework for a new one every year, as the lobster does, yet our bones are all the time being changed. They are probably never the same throughout any single hour of our lives.

The bones are supplied with millions of tiny holes, through which the smallest blood vessels wind their way, bringing food for the bone and carrying away waste matters. Thus the blood flows through every bit of bone as through any other living part of the body.

FIG. 10.—The Skull (Front View)

A, frontal, or forehead bone; *B*, left parietal bone, or left side wall of head; *C*, left temporal, or temple bone; *D*, left sphenoid, or wedge bone; *E*, left malar, or cheek bone; *F*, left upper jawbone; *G*, lower jawbone

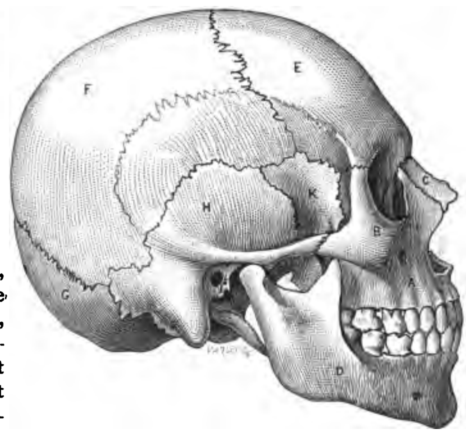

FIG 11.—The Skull (Side View)

A, right upper jawbone; *B*, right malar, or cheek bone; *C*, right nasal, or nose bone; *D*, lower jawbone; *E*, frontal, or forehead bone; *F*, right parietal bone, or right side wall of head; *G*, occipital bone, forming lower part of back of the head; *H*, right temporal, or temple bone; *K*, right sphenoid, or wedge bone

15. The Shape of Bones. — If you will look at the pictures of bones in this book, you will see that they are of many different shapes. Some are long and hollow, as the bones of the arm and the leg, while others are short, as the bones of the fingers and the toes. Some are flat, to cover exposed places, like the kneepan and shoulder blades, while others are of various odd shapes, as the bones of the ankle, the wrist, and the backbone.

FIG. 12.—The Top of the Skull, showing how the Bones are dovetailed together by Sutures

16. The Skeleton. — The **skeleton**, or bony framework of the house in which we live, — a house far more wonderful than any king's palace, since it can move about of itself and has living walls, — consists of the bones of the **head**, the **trunk**, and the **limbs**.

17. The Bones of the Head. — The bones of the top and back of the head make a very strong box, commonly called the **skull**. When we speak of the head we mean the head and the face. (Figs. 10 and 11.)

The top part of the head holds the brain. The skull is made up of several bones tightly fastened together by a kind of dovetailing similar to that used by a carpenter.

FIG. 13.—The Backbone, seen from the Right Side

These dovetailed joints are called **sutures**, meaning sewing, or seams.

If we put our hand on the head of a little baby, just above the forehead, we find a soft place, often called a "little fountain." Why is this? Simply because, in very young children, the edges of these bones do not yet meet, and the throbbing of the brain is easily seen and felt through the thin scalp. Thus a slight blow on an infant's head may do serious harm to the brain.

FIG. 14.—The Backbone, seen from Behind

18. What the Skull contains. — Let us see what the skull, or cupola, of our bodily house holds. There are the eyes with which we see, and the ears with which we hear. Then there is the mouth into which we put our food, and the nose with which we smell. And more than all, there is within it the brain with which we think.

19. The Trunk. — The **trunk** is the central part of the body. Its bones are those of the **backbone**, the **ribs**, the **breastbone**, and the **hips**.

20. The Backbone. — The **backbone**, or spine, the main pillar of our bodily house, is a tapering pile of twenty-six separate bones put one on top of another. The bottom of each fits exactly into the top of the next.

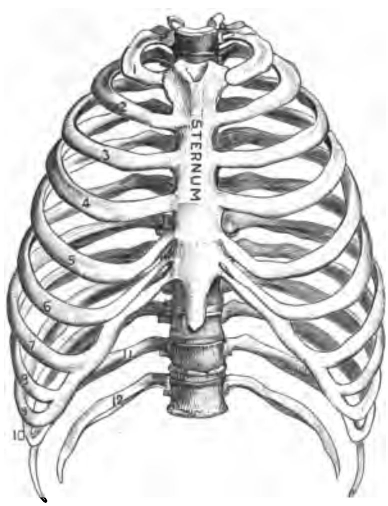

FIG. 15. — Showing how the Ribs are attached to the Sternum, or Breast-bone, and also showing the Back-bone (Front View)

Between the bones are little pads of gristle which serve, like the rubber tires of a bicycle, to break the force of any jar upon the backbone. (Figs. 13 and 14.)

Upon each bone of the spine there are knobs of bone to which are fastened muscles which keep the back erect. We can feel these bony ridges, or spines, by running the fingers down the middle of the back.

The next time you are to be served with fish for dinner, ask to be shown the large middle bone. It is the fish's backbone, and it will give you an idea of your own, for it is built on much the same plan.

21. The Spine as a Marvelous Machine. — The spine is built in a most marvelous manner, — a curious and wonderful piece of mechanism. It is so put together that it will bear a heavy burden and yet bend almost like rubber. Its three curves give the back its graceful form.

FIG. 16. — The Scapula, or Shoulder Blade

Think of the great weight which some people can carry on their heads with ease and safety. How often we see women in our large cities walking through the crowded streets with huge bundles of wood on their heads!

Perhaps you have seen performers in the circus, or in the theater, bend their backs until they can put their heads on the ground or clasp their legs around their necks. Such people rarely meet with an accident, although they are able to bring this wonderful pile of bones nearly into the shape of a hoop.

22. The Ribs. — The **ribs**, twelve on each side, slope downwards from the backbone and curve round, somewhat like the hoops of a barrel or a tub, to form the front wall of the chest.

The seven upper ribs on each side join the **breastbone** separately, but the next three are joined first to

one another and then bend up to join the seventh rib. The last two ribs are short and the front ends are not joined to any other bones.

FIG. 17.—The Humerus, or Large Bone of the Arm

23. The Hip Bones. — Every child knows how to rest his hands on his **hip bones.** These are the two large, strong, oddly shaped bones which support the lower part of the trunk, — the sills of the house, as it were.

Each of these bones has a cup-shaped cavity on its outer side, about as large as a small teacup, into which the head of the thigh bone fits.

FIG. 18.—The Ulna and the Radius, or the Two Bones of the Forearm

24. The Collar Bone. — The shoulder consists of the **collar bone** and the **shoulder blade.** These are the braces of the arms, one before and one behind each arm.

We can easily feel the **collar bone** reaching across the top of the chest, like a slender crossbeam, above the first rib. It is fastened at one end to the shoulder blade and at the other to the breastbone. The collar bone is greatly exposed to injury and often bears the brunt of a fall. No bone is oftener

broken than the collar bone. Even in children it is frequently broken by some slight fall or mishap.

25. The Shoulder Blade. — The **shoulder blade** is a broad, flat bone, and is easily found. Put your hand on your shoulder, where officers wear their epaulets, and move your arm back and forth. You will feel a bone which seems to move with every movement of the arm. This is the shoulder blade, which has a sort of cup or shallow saucer into which the rounded head of the arm bone fits. Thus a joint is made, in shape somewhat like a child's cup and ball. We can see this for ourselves in the bones of a shoulder of mutton. (Fig. 16.)

FIG. 19. — Bones of the Right Hand

FIG. 20. — Bones of the Right Hand and Wrist, as shown by an X-Ray Photograph. A Ring is plainly shown

26. The Arm and the Wrist. — The main bone of the arm is long and strong, extending from the shoulder to the elbow, where it meets the two bones of the forearm.

FIG. 21.—The Femur, or Thigh Bone

Below the forearm is the **wrist**, made up of eight little bones wedged together like the stones of a pavement, only not quite so firmly. (Figs. 17 and 18.)

27. The Hand. — Next to the wrist are the bones of the **hand**, ending with the thumb and fingers. (Fig. 19.)

The bones of the hand, wrist, and fingers are held in place by strong but flexible bands and cords. This permits great variety of motion. The hand, as everybody knows, can do almost anything, from grasping heavy tools to making the rapid and difficult movements required in ornamental pemanship and in operating a typewriting machine.

How wonderful it is that the deaf and dumb talk with their hands and the blind read with their fingers! Even the most common things that we do with our hands every day are really wonderful.

28. The Bones of the Legs. — We may think of the **legs** as like the two piers of an arch on which the whole weight of the body rests. Without bones in our legs

we could not stand or walk. They are made so strong that they can support the weight of the body, and yet so light that they are easily moved by the muscles.

The upper bone of the leg, the **thigh bone**, is the largest and strongest bone in the body. It is so large and heavy that warriors of certain savage tribes sometimes wear the thigh bones of slain enemies at their waists as weapons.

At the knee joint the thigh bone meets the two bones of the lower leg, to which it is united by stout cords and bands. These bones are the **shin bone** or **tibia**, and the slender **splint bone** or **fibula**, which are connected with the foot at the ankle joint.

FIG. 22.—The Tibia and Fibula, or the Two Bones of the Leg

29. The Kneepan. — A flat, three-sided bone, the **kneepan**, fits over the knee joint in front. If we fall in running, we are apt to strike on the knee. This little heart-shaped bone is the one that receives the shock.

We dare say that you have often watched a child when it is trying to walk. How often the little one tumbles on its hands and then drops on its knees. Little harm is done, for the kneepan protects the ends of the bones underneath it.

30. The Ankle. — The **ankle** contains seven queerly shaped bones, somewhat like those of the wrist, but rather larger. They are bound firmly together and are strong enough to bear the weight of the body.

FIG. 23. — Bones of the Right Foot, seen from the Side, showing the Arched Form

31. The Foot. — The **foot** forms an arch, known as the instep, which is not unlike the arch of a bridge. The heel is at the back and the toes are in front. On this arch the body rests.

The arch is not only very strong, but as the toes are formed of several bones the whole foot is made elastic, and forms a spring on which the body can be thrown in walking.

FIG. 24. — Section of the Bones of the Left Foot

Showing how the bones are joined, the arched form of the foot, the attachment of the tendon of Achilles, and also other tendons on the bottom of the foot

In animals which jump or spring for their prey this elastic character is increased; and they are provided with pads under each joint, which serve to break the

shock they would otherwise receive. You know how quietly and easily a cat runs and leaps. If you look at her paws, you will see that this is owing to the soft little cushions under them.

32. The Wonderful Things done by the Toes. — We have, as you know, ten **toes**, — five on each foot. The toe bones are much like those of the fingers. The toes help us to spring in walking. Bands and cords bind the twenty-six little bones of the foot firmly together and yet allow of many different motions.

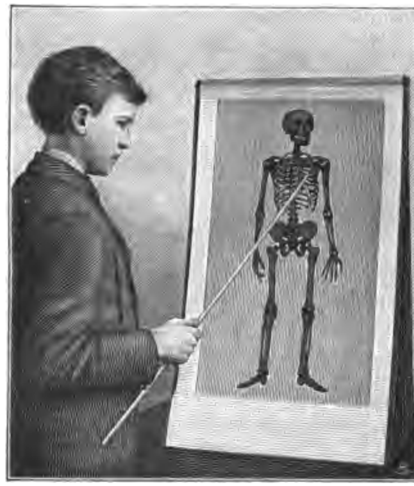

FIG. 25. — Review Exercise on the Bones

The pupil, with the aid of a blackboard pointer and chart, is describing in order the names, the location, and the uses of the various bones of the body. (From a photograph taken in the schoolroom)

The uses of the foot are many, and some of the things that may be done with the feet are wonderful. Armless men and women write, paint, sew, handle the knife and fork in eating, and have been known to play the violin with their toes alone. Chinese mechanics will pick up tools with their toes and work with them while using other tools with their hands. The Arabs use

their fingers and toes at the same time in braiding ropes. It is no wonder that the French people speak of the toes as "the fingers of the feet."

33. How Bones are joined together. — The place where bones meet and move upon each other is called a **joint.**

Get at the market a knuckle of ham or mutton. Open the joint by cutting into it, and study what you see. Our own joints are made after the same general plan. The ends of the bones, shaped, as you will see, according to the needs of each joint, are moist, and are tipped with a smooth, glistening layer of gristle.

FIG. 26. — Vertical Section through the Shoulder Joint, the Arm hanging down, showing how the End of the Arm Bone fits into the Shoulder Blade

34. How Joints are kept moist. — Joints are bathed with a thick and sticky fluid something like the white of an egg. This fluid oils joints. It allows the rubbing surfaces to move smoothly one on another, thus saving much wear and tear.

Think of a machine which would last "threescore years and ten," or more, and which could keep its own joints oiled all the time!

35. The Different Kinds of Joints. — Some of the joints are real hinges, which allow the parts to open and shut like the lid of a box. At the elbow we have a **hinge**

joint; we can move it only in two directions, that is, we can bend or straighten it. When a carpenter hammers he uses the hinge joint at his elbow. All our fingers and toes have hinge joints.

The most curious joints are called **ball-and-socket joints** because the ball-like head of one bone fits into the saucerlike socket of the other. When you move your arm backward and forward and twist it round like the arms of a windmill, you use one of these joints. A boy uses this joint when he turns a grindstone or swings a bat in playing baseball.

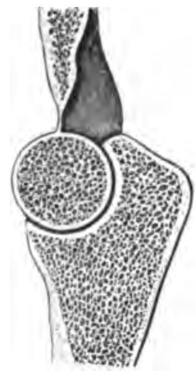

FIG. 27.— Elbow Joint sawed in two lengthwise, showing how the Lower End of the Arm Bone fits into the End of the Ulna

The round head of the thigh bone, as you already know, fits into a cup-shaped cavity in the hip bone, thus giving the legs greater freedom of motion.

36. How Bones may be put out of place. — The bones are liable to be put out of place at the joints. This often happens at the shoulder joint and occasionally at the elbow and the hip joints.

When we hear that a boy has put his shoulder out of joint it means that the head of the arm bone has slipped out of the shallow saucer in the shoulder blade. Those who play ball often put their finger bones out of place.

People ought to be very careful not to drag children along by one arm, or hold them up by their arms, as they often do. There is always danger of putting their shoulders out of joint.

Children should never pull the finger joints to make them crack, as it makes the knuckles larger and disfigures the hand.

37. How the Bones are tied to each other. — How are the ends of the bones held together? By strong straps, or **ligaments**, much as you fasten on your skates.

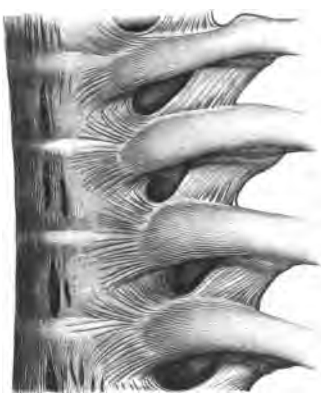

FIG. 28.—Showing how the Ribs are fastened to the Backbone by Bands, or Ligaments

Some of these straps, or bands, are as narrow as a flat shoe lace; others, as at the side of the knee or at the shoulder, are much wider. Some cross each other, as at the knee joint; while others entirely cover the joint, thus preventing the bones from being easily slipped out of place.

Sometimes these cords are strained or wrenched. The result is a **sprain**, which usually calls for prompt treatment on account of the pain and swelling.

38. Unnatural Growth of the Bones. — The bones of an infant will grow out of shape if they are put to unnatural

pressure for a long time. Perhaps you have read of certain wild races of men who do not live in houses nor wear clothes as we do. They believe that a baby's head should not be left as God made it; so they bind small strips of board firmly upon the soft and tender heads of their babies, to flatten them, thinking that a flattened skull of this shape is beautiful.

FIG. 29.—Showing how the Bones of the Head may be artificially deformed by Pressure during Infancy

(Based upon a photograph of an Indian Skull found in the West Indies)

We dare say you have heard of the distorted feet of Chinese women. These people think it is lowbred for women to be useful and to have natural feet; so they bind the baby's feet, if it is a girl, with strong bands, to prevent their growing. When these poor children become women they are scarcely able to move about.

FIG. 30.—Effects of Poorly Fitting Shoes upon the Bones of the Feet

The large toe of either foot is crowded on to the second toe, and the remaining toes are pressed together in the wrong direction. (Based upon a photograph from life)

39. Poorly Fitting Boots and Shoes. — Did you ever think how hurtful and silly is the fashion of wearing tight and high-heeled boots and shoes? Why is it so? Because high heels throw the weight of the body forward and force the

foot down on the toes. This crowds the toes out of place and destroys the beauty of the foot, besides causing much pain and discomfort. After a time such unnatural pressure produces tender feet, corns, bunions, ingrowing nails, and swollen joints.

Knowing the practical importance of having comfortable feet, Frederick the Great, it is said, kept a servant whose foot was exactly the same size as his own, and made him wear his new shoes till he himself could wear them with comfort. The Duke of Wellington, being asked once as to the most essential part of a soldier's clothing, replied, "A good pair of shoes." — "What next?" — "A spare pair of shoes." And even thirdly, "A spare pair of soles."

40. Hints about the Care of the Bones. — Good food, fresh air, and sunlight will do much to keep the bones well and strong. From lack of these things the leg bones in children may become bent, or the chest may grow out of shape.

Schoolroom seats should not be too high nor too low, but of a height that will enable the pupil to rest his feet squarely and easily upon the floor. If the seat is too high or too low the shoulders, spine, and legs may be cramped and grow out of shape.

Of course no one of us would like to become round-shouldered. We must learn then to keep ourselves erect, with the shoulders thrown back, both when sitting and

when walking. A little care when one is young, will keep the body erect through life. The sooner we learn to exercise this care, the better it will be for us.

Children should not be urged to walk too early, before the bones of their legs are hard and strong enough to bear the weight of their bodies. The bending of the soft bones may after a time cause a child to become bow-legged.

41. Effect of Tobacco on the Bones. — As the bones grow they need material for building them up. If the blood is made poor or poisoned with alcohol or tobacco, the bones are deprived of the matter they need for their growth. Physicians testify that tobacco tends to stunt the growth of the bones.

Many boys are dwarfing their bodies as well as their minds by smoking cigarettes. Every boy wants to be a tall, well-formed man. He cannot afford then to form any habit that will interfere with his growth.

QUESTIONS FOR REVIEW

1. To what may the bones of our body be compared?
2. What useful purposes do the bones serve?
3. How many bones are there in the body?
4. Of what is bone composed?
5. What do you know of the general structure of bone?
6. What can you tell of the general shape of bones?
7. Of what does the skeleton consist?
8. Tell what you can about the bones of the head.
9. What does the skull contain?
10. How will you describe the backbone in some detail?
11. What can you say of the backbone as a marvelous machine?
12. What are the ribs?
13. Describe the hip bones.
14. How will you describe the collar bone and the shoulder blade?
15. Name and describe the bones of the arm.
16. Mention the bones of the leg and describe each one.
17. What are some of the wonderful things that may be done by the toes?
18. How are bones joined to each other?
19. Describe the different kinds of joints and give illustrations of each.
20. How may the bones be put out of place, or dislocated? Give some familiar illustrations of the accident.
21. How are bones fastened to each other?
22. What can you say about the unnatural growth of bones as illustrated by practices of certain races of men?
23. What may be the effect of wearing poorly fitting and high-heeled boots and shoes?
24. What hints can you give about the care of the bones?
25. How may tobacco affect the growth of the bones?

CHAPTER III

THE MUSCLES AND HOW WE MOVE

42. The Muscles. — We move and walk from place to place by means of our **muscles.** Our limbs are moved by them. Muscles move not only the limbs but also the skin. Watch the horse and see him shake his hide to get rid of the biting flies. Our bones, our fingers, our toes, our lips, and our eyelids, — all are moved by muscles.

In short, the chief use of muscles is **to cause movement in the various parts of our bodies.**

43. How Muscle looks. — Muscle is simply the lean meat or the flesh which covers the bony framework. When we eat roast beef or mutton chops for dinner we are eating muscle.

When corned beef is boiled until it becomes "stringy," we can easily pick it apart with a needle into little threads. These threads are bundles of muscular fibers. They are bound together into larger bundles by a very thin web not unlike the thinnest tissue paper. Each of the largest bundles is called a muscle.

We may compare a muscle to a handful of tiny skeins of silk packed into bundles, the smallest thread of which is a thousand times finer than the finest hair.

44. The Size and Shape of Muscles. — Muscles are of many sizes and shapes. There are a great many of them in the body, — about five hundred. Some are large, others very small; some are shaped like fans, others like feathers. Many are broad and flat in the middle and taper at each end.

Experiments. — Obtain from the market or at home a small piece of lean corned beef. Use fine needles with which to pick apart the bundles and fibers of the muscular tissue. Continue until it is difficult to see the tiny fibers with the naked eye. The experiment may be continued with the aid of a hand magnifying glass.

FIG. 31. — A Schoolboy who has secured a Large Muscular Development by the Use of Dumb-Bells is engaged in "Trying his Muscle"

(From a photograph of the living model)

The large muscle of the arm (biceps) may be utilized to show how muscles contract and relax. This simple experiment is commonly known as "trying your muscle." Stretch out the right arm. Now bring the forearm slowly and vigorously toward the shoulder, keeping the elbow firm. The mass of flesh on the front of the upper arm (biceps muscle) may be seen and felt to become harder and thicker as the closed hand is raised. The biceps thus contract. Keeping the elbow in the same position, extend the forearm. As the muscle relaxes, it seems to become softer and smaller.

In brief, the muscles vary in size and shape according to the places where they are found and the work they

have to do. Sometimes we can trace them under the skin, as in the arm and shoulder of a man who does hard work. See the brawny arm of the blacksmith as he works at his forge. Look at those large muscles, "strong as iron bands," that bulge out as he brings his hammer down on the anvil.

FIG. 32.—Well-Developed Muscles of the Arm and Back, as shown in the Same Model as in Fig. 31

45. How the Muscles do their Work. — Muscles have a peculiar power of their own which is possessed by no other organ of the body. That is, they do their work by becoming shorter and thicker.

We see something like muscular action in a piece of india rubber. If we take a piece of this and stretch it, we see that it becomes thinner. When we let it go it snaps back and once more becomes shorter and thicker. Muscles work in a somewhat similar way. The great difference is that the rubber cannot contract until it has been stretched.

46. Muscular Action illustrated by the Muscles of the Arm. — Let us see how this power in our muscles enables us to move. What happens when we bend the arm, as boys do to "try their muscle"?

Stretch out your right arm and grasp it above the elbow with your left hand, halfway to the shoulder. Now bend it firmly and briskly up and down, and feel the big muscle on the front of the arm swell and harden as you grasp it with your hand. Let us see what has happened.

47. How Muscular Action is produced. — When you wish to draw up your hand toward your shoulder the brain sends a message to the muscle. The muscle at once shortens and pulls up the forearm towards the shoulder.

FIG. 33. — Superficial Muscles on the Right Side of the Head, Neck, and Chest, and also those of the Inner Side of the Left Arm

Watch the bare arm of a strong man while he raises his hand to his shoulder and you will see the muscle swell up as it becomes thicker and shorter. All similar movements, such as closing the hand, opening the mouth, and lifting the leg, are really made in the same way.

This is muscular action. The growing thicker and shorter is called the **contraction** of a muscle.

All muscles act by contraction, though not all the muscles are fastened to bones. Thus the tube through which

food passes from the mouth to the stomach is made up in part of rings of muscle. These rings contract one after another, and thus the food is pushed by a wavelike motion into the stomach. One of the muscles of the mouth is in the shape of a ring. This enables us to pucker our lips.

FIG. 34.—Superficial Muscles on the Side and Back of the Right Leg. The Tendons of the Leg and Foot are well shown

48. Some Muscles not under our Control. — There are some muscles in our bodies, however, which are not under the control of our will. These act and move and do their work whether we wish it or not. Indeed, they even act when we are asleep.

FIG. 35.—Superficial Muscles on the Inner Side of the Left Leg

The stomach, for instance, which digests our food, has muscles in its walls which we cannot control. As soon as we swallow a mouthful of food, and it passes into the stomach, the nerves feel that it is there and the muscles act in the proper manner to digest it.

49. The Heart as a Muscle. — The heart, which pumps the blood, is really a muscle which does its work without our even thinking about it. We know that the heart is always beating. If we place one hand on the left side, we always feel it beating. It seems to say "lŭb, dŭp," and never stops as long as we live.

If we had to will every beat of the heart, how annoying it would be even when we are awake! We should not be able to think about anything else and we should never dare to go to sleep.

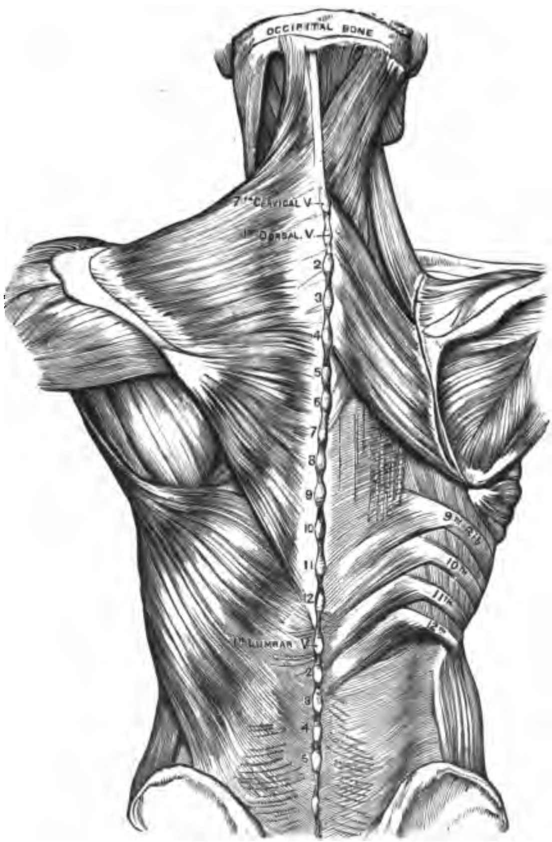

FIG. 36. — A Few of the Larger Muscles of the Back

On the left side of the body the larger superficial muscles are shown. On the right side the superficial layer is removed, exposing the deeper layers of muscles

Years ago a man lived in Ireland who could, by an effort of his will, cause his heart to stop beating for a few moments. He at last lost his life in the act.

Let us then remember that although all of the muscles are under the control of the nerves, not all of them are controlled by the will. Some muscles, such as those of our hands, our feet, our eyes, and our lips, which have to do different things at different times, are under the control of the will and do what we bid them.

FIG. 37.— Diagram showing Some of the Muscles of the Upper Part of the Body that may be developed by Horizontal-Bar Exercise

(Based upon a photograph of the living model)

50. The Tendons. — Some muscles are fastened directly to the bones. Other muscles are not fastened to bones by their fleshy parts, but by their fibers, which taper into tough white, shining cords called **tendons.**

If we put the fingers on the front part of the wrist and then work the hands and fingers, we feel some cords just beneath the skin. These are tendons, — the little ropes with which the muscles in the forearm pull the hand and fingers. (Fig. 42.)

If we bend our fingers to and fro, we can see the tendons move on the back of the hand. Children often amuse themselves at Thanksgiving time by pulling the white cord or tendon in the leg of a turkey and seeing its toes move.

FIG. 38. — Diagram showing Some of the Large Muscles of the Left Side and Back that are brought into Play in a Ladder Exercise

(From a photograph of the living model)

Experiment. — With the aid of the marketman, or some friend, obtain the leg of a fowl, a turkey, or a lamb. Cut away the parts until the tendons are exposed. Pull on the tendons, noting how they serve to move the feet and the toes.

51. What Tendons are used for. — Tendons save a great deal of space and allow great freedom of movement where muscles large enough to do the work would be bulky and clumsy. What large and awkward feet we should have if all the muscles which are needed to pull the toes were in the foot!

The longest and strongest tendon in the body is just back of the ankle (Fig. 41). It is called the **tendon of Achilles**, after the Greek hero of that name.

According to one story Achilles received his death wound in the heel, no other part of his body being liable to injury.

Perhaps you have noticed that the marketman uses this strong tendon with which to hang up on hooks legs of mutton and great sides of beef.

Fig. 39. — Diagram showing Some of the Muscles on the Back of the Body that are brought into Play in pushing a Boat

(Based upon a photograph of the living model)

52. Ill Effect of Alcoholic Drinks upon the Muscles. — Will alcoholic liquors make the muscles stronger? Will they enable the drinker to do more or better work? These are questions which every one should be able to answer correctly.

It used to be thought that these drinks were a help to people who had to do hard work with their muscles, because it made them feel better for a little while. So when the farmer had a big day's work for his men in the hayfield he gave them hard cider or some other alcoholic drink, believing they could work better for it. Rations of rum were served to sailors when they had extra hard work to do, or were exposed to severe weather.

But after a time it was noticed that men who did not take these drinks could do better work and keep at it longer than those who did. They were not so tired when night came and were in better condition for work the next day.

FIG. 40. — The Shoulder Joint, showing the Cut Ends of a Few Tendons

53. Effect of Alcoholic Beverages upon Muscular Work. — Careful tests have been made recently to find out the effect of alcoholic beverages upon the working power of large bodies of men.

FIG. 41. — The Tendon of Achilles

A number of workmen were once divided into two companies, each engaged in the same kind of work. For a week the men in one company took no alcoholic drinks of any kind; the men in the other drank as usual. Before the end of the week the men who were using no alcohol found they could do more work with less fatigue than when they drank beer. The next week the other company of men made the same trial, and with the same result. A trial was made with companies of soldiers on a long

march. Some companies were given alcoholic drinks, others none. At the end of the trial those who had taken no drink containing alcohol came out ahead.

A six-day bicycle race took place a few years ago in New York. The man who won the race was a total abstainer from all alcoholic drinks, as was also the one who came in second. The third man drank a little while he was training, and the fourth took a glass of beer once in a while.

FIG. 42.—Tendons on the Back of the Left Hand

Occasionally one hears of a strong man who uses some alcoholic liquor, but this is no proof that the drink makes him strong or that he would not, like other men who have made the trial, be stronger without than with such drinks.

54. Effect of Tobacco on the Muscles. — Tobacco causes weakness and unsteadiness of the muscles. Applicants for the position of bookkeeper are frequently rejected because of the tobacco habit, which shows itself in their unsteady handwriting. One of the first things demanded of a young man who is going into training for a foot race is to stop smoking.

QUESTIONS FOR REVIEW

1. How do we move from place to place?
2. How can you show the action of muscles in different parts of the body?
3. How may we sum up the chief use of muscles?
4. What is muscle? Illustrate.
5. How does a piece of well-boiled beef illustrate the structure of muscle?
6. To what may muscle be compared?
7. What can you say of the size and shape of muscles?
8. What peculiar power has muscular tissue?
9. How may india rubber serve to illustrate muscular action?
10. Show how the muscles of the right arm may be used to illustrate muscular action?
11. How is muscular action produced?
12. What is meant by muscular contraction?
13. How may we illustrate muscular contraction by means of the food tube?
14. What can you say of muscles that are not under our control?
15. How does the heart act as a muscle?
16. What muscles are under the control of the will?
17. What are tendons?
18. What purpose do tendons serve?
19. How may the fingers illustrate the action of tendons?
20. What are tendons used for?
21. What is the tendon of Achilles?
22. Do alcoholic beverages make the muscles stronger?
23. What tests have been made to show the effect of alcoholic drinks upon workmen?
24. What other tests have been made upon soldiers in other feats of endurance?
25. What is the effect of tobacco upon the muscles?

CHAPTER IV

PHYSICAL EXERCISE

55. The Importance of Physical Culture. — The best way to keep a machine in working order is to use it. By proper and moderate use we should expect to get better results than if we wore out a machine by long or hard use or allowed it to stand idle.

We have already been told that our bodies in some respects are like machines and may be compared to a locomotive. Dr. Oliver Wendell Holmes has well said that our bodies are like clocks. "The angel of life winds them up and gives the key to the angel of resurrection." Should it not then be our duty to see to it that our bodily clocks are kept running in the very best order?

As keepers of these clocks we would not have them run down before their time or get stiff or useless for lack of proper care. No, indeed, for all of us want to live useful, healthy, and happy lives, as free as possible from ills and worry. To do this we must keep our bodies in good physical condition.

56. The First Step toward Physical Culture. — The first step toward physical culture is to realize the importance

of beginning and carrying out a series of systematic exercises. One half of the battle of physical training has been won when boys and girls begin to take a real interest in their bodily condition.

We need to take **physical exercise** as much as we do to eat our daily meals. How foolish to say, "I feel well enough; I don't need

Fig. 43. — Coasting

exercise." The wise person is one who takes his regular out-of-door exercise daily for the sake of his health. A famous doctor says, "I would rank exercise and an out-of-door life far above any known remedies for the cure of disease."

57. Muscles made Stronger by Use. — Every part of our bodies ought to be used if we wish to keep well. We all know what stout, strong arms a wood chopper or a teamster has. Why are their muscles so strong and

firm? It is because they are used so much. Regular use, instead of wearing the muscles out, as it would if they were merely tools, gives them strength and firmness.

It is just the same with all the other organs of the body. A person who uses his eyes as he ought usually has keener eyesight than others and sees many things which others cannot see. One who uses his ears as he ought hears much that others do not hear.

FIG. 44. — Baseball

We are told that savages, who look and listen intently for enemies or game, have eyes that are actually keener and larger than ours, just as the ball player's arm grows larger by regular use.

58. Every Part of the Body made Stronger by Exercise. — Any part of our body that we do not use tends to become weak and helpless. Let the trained football player change his work for that of a clerk, and the once brawny arms become smaller and weaker. Perhaps you have read of certain people in India who, as an act of worship, keep one arm raised above the head until the muscles become feeble and useless. When a broken arm or leg is kept in splints for several weeks the muscles shrivel and lose their vigor.

All the parts of the body have so much to do with each other that each one has some effect on all the others. Now what we commonly call taking exercise — that is, walking, running, and jumping — not only strengthens our arms and legs and backs but also makes the blood flow faster and more briskly.

Fig. 45. — Skating

59. Exercise for Boys and Girls. — What a good thing it is for boys and girls that they are so fond of play! Playing baseball and football, running races, riding the bicycle, skipping with a rope, — all these things help them to grow up into active, healthy men and women.

The old adage says, "Change of work is as good as play." There is a sense in which this is quite true. If boys or girls have been sitting and reading a long time, it rests them to get up and take a walk in the open air. If they have taken a long walk, it rests them to sit still and read for a short time. Thus a change of work will sometimes take the place of play, because it exercises different parts of the body.

60. The Kind of Exercise needed. — To keep well and strong we do not need to do great feats of strength, or even to increase very much the size of our muscles; but the main thing is to take moderate exercise of some kind every day.

We can easily understand that much depends upon our daily work. A man ill with indigestion once consulted a doctor, and was advised to walk several miles a day. When the patient told the doctor that he was a letter carrier, the physician gave him other advice.

FIG. 46. — Bicycling

Teachers, students, printers, and clerks in stores often suffer from lack of outdoor exercise, while teamsters, mechanics, and farmers rarely need any more exercise than they have in their occupation. Every sensible person must decide for himself what kind of exercise is best suited to his own needs.

61. Getting too Much Exercise. — It is very plain that our muscles need regular exercise. It is also important to remember that we must not get overtired in taking exercise. Children, as well as older folks, sometimes do themselves more harm than good by exercising after they have become tired. Young folks soon become cross, peevish, and nervous, and are unfit for study at school. This may be as true of those who get overtired in helping in household work as it is of those who overdo in playing basket ball, tennis, or football.

62. Physical Exercises at Home. — The graceful physical exercises which are practiced in so many of our schools and gymnasiums are especially useful and healthful, and should be more generally used in our homes. Children should be taught, both at home and in school, the use of light wooden dumb-bells, light clubs, or dumb-bell wands.

The various "health exercisers" so widely used at the present time are useful helps in taking exercise in one's room. They are inexpensive, convenient, and easily adjusted. They are always used with a real benefit.

A daily exercise of ten minutes before breakfast and at bedtime will greatly aid to develop feeble and narrow chests, and to check a tendency to curvature of the spine and round shoulders, which is so common with growing children. Such physical training, if properly and patiently carried on, will give grace and freedom of movement as well as strength and vigor to all parts of the body.

63. Physical Exercises in Schools. — Safe, simple, and inexpensive physical exercises can be easily used in any schoolroom. Teachers and pupils should look for them as a matter of course, just as they would for a lesson in arithmetic or geography.

Such exercises, if rightly directed, are interesting and profitable. They will go far towards giving the pupils an erect and healthy carriage.

Physical exercises, if followed up as steadily and faithfully as other lessons, will in time increase the size and the strength of the muscles. They will make many a round-shouldered boy or girl straight, increase the size of the chest, and so lessen the risk of having a curved spine, rounded shoulders, a delicate throat, and weak lungs.

Will such exercises take too much time from your lessons or bother you about studying them? No, indeed. It is found that children go back to their lessons fresher and brighter after having the short rest from the regular studies.

64. Helps in Indoor Exercises. — A variety of exercises can be practiced at home or in the schoolroom at the cost of only a few cents for apparatus. Good results are sure to follow if these exercises are faithfully practiced. Saw off the handle of an old hoe or broom. This will make an excellent wand. A pair of wooden dumb-bells costs only a trifling sum.

With simple gymnastic exercises, a wand, and a pair of light dumb-bells, we have the means of securing all the indoor physical training ever needed to make shapely and enduring bodies.

65. The Use of "Health Exercisers." — At the proper time children should be taught to use a "health exerciser" of standard make. This useful apparatus may be readily put up in a few moments at any convenient place about the house. Such apparatus is so cheap that all but the very poor can own it as readily as the rich. Every boy and girl should use one of these exercisers half an hour every day, especially during the winter months, for the health, strength, and grace it brings.

FIG. 47. — Schoolgirl practicing on a Health Exerciser

66. How Deep Breathing does good. — Deep breathing plays an important part in every kind of physical training. Boys and girls, as well as older people, should be taught to take long, deep breaths. Let us read how it is done.

While standing or sitting slowly fill the lungs. Hold the breath for a few seconds, then slowly breathe out. This tends after a time to make the chest larger and the lungs stronger, especially when combined with regular dumb-bell exercises.

Again, proper breathing helps to guard us against colds, coughs, and other chest troubles. Deep breathing also causes the blood to flow faster. We feel warmer in the coldest weather after breathing deeply, even if we are thinly clad.

A shrewd doctor says that he once had good reason to remember this fact. One night, when he felt half frozen, he began taking deep breaths, keeping the air in his lungs as long as possible. The result was that he was comfortable in a few minutes.

FIG. 48. — School-girl practicing Wand Exercises

67. Hints on Proper Breathing. — Proper breathing has much to do with keeping our bodies in sound and vigorous health. It is very important that every one, especially pupils at school, should be taught to breathe properly.

Did you ever watch a child breathe during sleep? If so, you must have noticed that the breath is long and deep if the sleeper is in a natural position.

What must we do to breathe properly? In the first place, pure air is really necessary. Exercise in a close and badly ventilated room is of little benefit, for the lungs are then forced to take in foul air.

FIG. 49. — Schoolgirl practicing Light Gymnastic Exercises

The doors and windows of the schoolroom should be freely opened during exercise, so that the children may have plenty of pure, fresh air.

We should get into the habit of breathing at all times through the nose. This is especially necessary in cold weather, so that the air may be warmed before it is taken into the throat and lungs.

Are you bothered with shortness of breath when you begin any brisk exercise, like running or leaping? The reason may be because you have never been trained to breathe properly. Practice filling your lungs with fresh, pure air and taking long, deep breaths.

68. Various Kinds of Useful Exercises. — Walking out of doors is perhaps the most convenient of all exercises. It takes us into the open air and the bright sunlight; it

gives vigor to many important muscles of the chest, the abdomen, and the limbs.

With a brisk walk every day in the open air no one need suffer from lack of proper exercise. While walking, we should practice deep breathing.

Running, leaping, climbing, and other vigorous sports are excellent exercises if we do not get overtired. Baseball and football are severe exercises and demand skill and adroitness of action.

FIG. 50. — Schoolgirl practicing Dumb-Bell Exercises

Rowing is well suited to most persons of either sex. Horseback riding, golf, basket ball, coasting, swimming, and skating are important helps in increasing bodily vigor.

69. How to have Broad Shoulders and a Full Chest. — Why is it that some people have such narrow chests, such round shoulders, and stoop over so much when they walk? Their daily work may have much to do with it. A

workman at his bench, a clerk in the store, or a boy or girl at the school desk is almost sure to have round shoulders unless a correct position is kept.

The trouble is that the muscles of the back are not used enough. The way to correct this habit of bending over is to practice sitting and standing erect, to take long, deep breaths, and to exercise the proper muscles while in a correct position.

Dumb-bell or chest-weight exercises alone, if properly and regularly taken, will soon make the chest and arms large and well shaped, the shoulders square and firm, and the back strong and straight.

70. The Best Time to take Exercise. — Moderate exercise is healthful at almost any time. After a full meal, as the stomach is busily at work digesting food, severe exercise may hinder its action.

The evening is not the best time for brisk exercise, because one is usually tired after the work of the day.

A moderate amount of exercise can be safely taken before breakfast, after the morning's bath, provided a glass of milk is drunk or a bit of plain food is eaten first.

A brisk walk just before bedtime for those who study hard or are disposed to worry will do much to quiet the excited nerves and thus induce sound sleep.

71. Improper Positions in the Schoolroom. — How often we see boys and girls sitting or standing in an improper position in the schoolroom! The seats and desks are

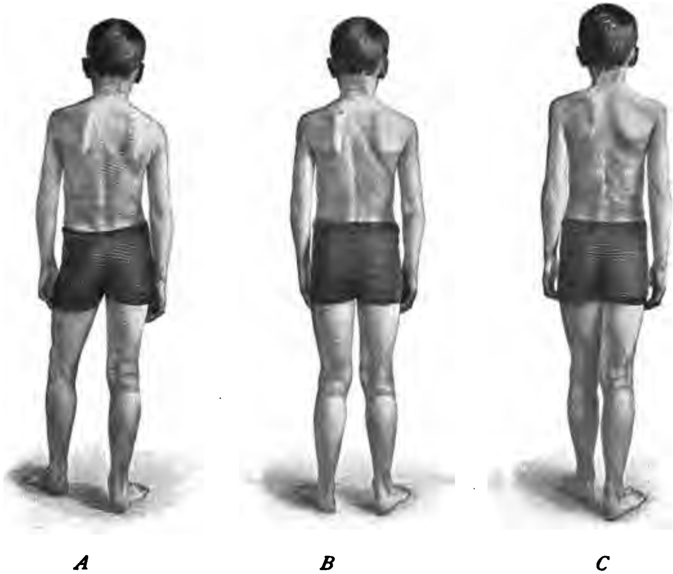

FIG. 51.— Positions in Standing. (Based upon photographs of a sixth-grade pupil which were taken in a school gymnasium)

A. This is a position often taken in the schoolroom by boys and girls. The right leg supports the trunk, and the left leg is thrown out as a brace. The left hip is lowered and the left shoulder raised. This position tends to bend the spine to the left and displace the intestines and other internal organs to the right. No good teacher will allow pupils to take such a faulty position.

B. In this position the trunk is well balanced on both legs, with neither of the heels in advance of the other. The hips are drawn back, the chest thrown forward, the head is a trifle back, and the weight is well poised on the balls of the feet. This is a correct position for standing, but one which the pupil will not keep long. It soon becomes tiresome, as both legs are put to the same muscular tension.

C. This is the best position to be taken in long standing as a change from that taken in *B.* As one foot is somewhat in advance, the weight of the body can be easily shifted from one leg to the other, thus giving the needed relief and change to the muscles.

often so ill fitted to those who are using them that they invite postures which tend to cause bodily deformities. It was discovered a few years ago that one fifth of all the girls in the grammar grades of a large city were round-shouldered as a result of bad positions due to defective desks and seats. Pupils who differed seven years in age and nearly two feet in height were seated at desks and in chairs of exactly the same size. Out of a hundred girls in another school only one fifth when sitting back in their seats could touch the floor with their heels.

FIG. 52. — An Incorrect Position at a School Desk

This position is frequently seen in the schoolroom. This pupil has the use of an adjustable desk and seat, but because he is tired or indolent he has slipped forward in his seat. He is resting nearly his whole weight on the end of the backbone and the shoulder blades. Such a posture, among other things, tends to make the pupil round shouldered and to produce a backward curve in the backbone

Even with improved and well-adjusted desks, pupils soon grow tired of one position and readily take improper postures. The fault is by no means always with the desks and seats. Pupils are sometimes so busy at their books and at

other times are so overtired, lazy, or careless that they assume injurious positions.

Improper positions in standing are often seen in the schoolroom. These postures are not so harmful as those taken in sitting, because they are usually kept for a much shorter time.

FIG. 53. — A Correct Position at a School Desk

In this position the pupil sits erect, resting the bones of the pelvis squarely on the seat. The head is so poised that the line of direction is brought within the line which joins the bones of the pelvis resting on the seat

72. Exercises to give Relief and to correct Improper Positions. — Pupils should not be kept at their desks until they are so cramped and overtired that they cannot keep a proper position. The trouble is that some muscles are not used enough, while a few are used for too long a time. How shall we get some relief and a change both for the overworked and the inactive muscles? Besides the recess, there should be frequent short periods of rest from standing or sitting at the desks. These periods should be used for some sort of physical exercises which will give relief to the

overtired muscles, bring into play muscles not used at the desk, and tend to correct habits of wrong positions.

Parents, as well as teachers, should take the greatest care to prevent the improper positions which children are apt to take, both at home and in school, from becoming fixed habits. For instance, how often we see boys and girls get into the habit of sitting at the school desk, or in an easy-chair, with one leg crossed over the other. How often may groups of girls be seen on their way to and from school carrying text-books propped upon the left hip. This in time causes a twist of the spine with a curve toward the left.

73. Hints on taking Exercise. — The time when we feel least like taking exercise is usually the time when we most need it. Tired people often shrink from the very exercise they should seek. No kind of work about the shop, house, or farm develops the body equally. This is the real reason why everybody needs to have regular drill in some form of physical exercise.

Violent exercises that strain the body often do more harm than good. Feats of strength or skill should not be made a feature of the drill at home or in the schoolroom.

Clothing should be worn that will allow free play to all muscles of the body. It should be light, loose, and made of porous material.

Extra clothing should be worn after prolonged exercise. There is always danger of taking cold in standing

about in the open air if the clothing is damp with sweat. When it is convenient the body should be rubbed down thoroughly after severe exercise, and the clothing changed.

74. Alcoholic Beverages and Tobacco forbidden in Gymnastic Work. — A gymnasium or similar place for the physical training of young people is now found in almost every large town. Furnished as it is with excellent apparatus, suitable bathing facilities, ample dressing-rooms, and other conveniences, it is well fitted not only to benefit but also to delight all who are able to use it.

Physical instructors look sharply after the daily living of their pupils. A complete record is kept of bodily measurements, progress in the use of apparatus, the condition of the heart and lungs, and many other details which concern good health. Instructors advise and urge those under their charge to secure a goodly amount of sleep, to take frequent baths, to wear proper clothing, to eat wholesome food; and are otherwise watchful in suggesting those things which underlie sound health.

Such teachers rightly forbid the use of tobacco and alcoholic drinks, as do those who train men for professional sports. They know from experience that those who become addicted to such habits cannot long make any real progress in systematic physical culture. Such a rule is more strictly enforced with those young men who are training for athletic contests, yet it applies quite as well to those who exercise only to keep well and strong.

QUESTIONS FOR REVIEW

1. What is the best way to keep a machine in good order?
2. How may the body be compared to a clock?
3. What is the first step towards physical culture?
4. Why do we need to take regular physical exercise?
5. What makes the muscles of some people strong and firm?
6. What may be the effect of proper use of the eyes on the sight?
7. How does change of work affect the muscles? Illustrate.
8. What kind of exercise is good for boys and girls?
9. What does an old adage say? Illustrate.
10. What do we not need to do to keep well and strong?
11. How does the kind of exercise one should take depend upon his daily work?
12. How many illustrations of this principle can you remember?
13. What are some of the ill effects of taking too much exercise?
14. What can you say about taking physical exercises at home?
15. How may "health exercisers" serve as useful helps?
16. What is the value of taking physical exercises in school?
17. What inexpensive but useful apparatus may be helpful in taking exercise at home or in school?
18. What is deep breathing, and what useful purpose does it serve?
19. What must we do to breathe properly?
20. What are some of the more common kinds of useful physical exercises?
21. How may we have broad shoulders and a full chest?
22. Why are improper positions often taken by pupils in the schoolroom?
23. How may the habit of taking harmful postures in the schoolroom be corrected?
24. What rules should be followed in taking exercise?
25. How does the use of tobacco and alcoholic drink interfere with physical exercise?

CHAPTER V

WHAT WE EAT AND DRINK

75. Why we need Food. — Food is to our bodily machine what coal, wood, and oil are to the engine. We move from place to place and are kept warm because a slow fire is always burning within us. This fire, like that of the locomotive, must have fuel and air. Without them the fire in the engine would soon go out. The same is true of our bodies. Without fresh air and fuel every day of our lives the slow fire within us would go out and we should soon waste away and die.

76. Wear and Tear of the Body. — We all know that every part of the steam engine is always wearing out. It is also the same with our bodies. They are all the time wearing away.

Every beat of the heart, every movement of a muscle, the wink of an eyelid, and the twist of the tongue, even every word we speak, — all these lead to waste. Every step we take, every moment we breathe, even every time we think, wastes a small part of our bodies. In short, we are working and wasting all the time, at the expense of some portion of the body.

77. Why we do not waste away. — Why do our bodies not waste away completely? We weighed this morning just as much as we did three days ago; some of us, we hope, a little more. How can this be? Why, we have been doing something else, part of the day, besides working and wasting. This something was to eat our dinner yesterday and our breakfast to-day.

The whole story in a nutshell is this. What we eat and drink takes the place of what is used up or wasted. If we are young and growing we must take in a little more than the actual waste.

In brief, nearly all this waste is made good by what we eat and what we drink. The rest of the waste is made up from the air we breathe.

78. The Wonderful Change made in the Food we eat. — The food we eat, you may think, does not look much like our bodies, of which it is to become a part. Perhaps you may think the meat is rather like it; but how about bread, milk, butter, and potatoes?

How are all these things turned into flesh, hair, and bone? How, indeed, do they ever get to them, — to the tips of our fingers and toes, to our eyelids, to our brain, in fact, to every nook and cranny of our bodies?

It can be told in four words: **the blood carries them.**

The blood, as we shall learn later, carries nourishment to every part of the body. In brief, as the Scriptures say, "The blood is the life."

In Chapter VII we shall learn a few things about this wonderful change of food into blood.

79. What the Body must have for its Food. — Let us stop for a moment and remind ourselves that the whole world is made up of what men of science call **elements** and their compounds. Of the seventy different elements such as oxygen, carbon, lime, sulphur, and iron, only about a dozen are found in the human body.

Now, if our bodies are built up of these elements in their various forms we can well see that the food which we eat must be made up of the same substances. If it were not so we should soon waste away and die.

FIG. 54. — A Schoolboy at the Blackboard describing the Four Great Classes of Food

NOTE. — The blackboard, as well as notebooks, may be utilized by pupils for tables and analyses of general topics in the study of physiology as profitably as it is used in arithmetic or language work

80. Four Great Classes of Food Materials. — It will help us to understand much better the subject of foods and their digestion if we arrange them into the four great classes: (1) **proteids** (substances similar to the white of an egg), (2) **starches** and **sugars**, (3) **fats** and **oils**, (4) **mineral foods** (water and salts).

To these groups or classes of food the name of **food materials** or **food stuffs** has been given. Each of them is made by the combination of several elements.

81. The Proteids. — As the **proteids** alone contain the highly important element known as nitrogen, they form a group by themselves. They are often spoken of as **nitrogenous** foods.

The type of this class of foods is egg albumen, which we all know as the white of an egg. The chief proteids we eat are the animal proteids found in lean meat, the white of eggs, and the curd of milk. Then there are the vegetable proteids found in corn, oatmeal, wheat flour, peas, and beans.

Experiments. — Put a tablespoonful of water into a test tube, adding a few drops of the raw white of egg. On heating the tube over a lamp, the mixture will turn white and become thicker. The white of egg is a type of a group of proteids. Heat has the power to thicken or coagulate proteid.

After tying a small piece of wheat-flour dough into a cotton handkerchief, knead it under water. The starch is soon washed out, leaving the sticky mass of gluten on the cloth. Gluten is made up in part of a form of proteid.

If we heat a little sweet milk in a test tube, it will not coagulate or curdle. If we add a few drops of vinegar and gently shake, the milk curdles and separates into a solid curd which is the chief proteid of milk, and fat and a yellowish fluid known as whey.

What need of the body do the proteids supply? Let us remember it, — they furnish the material from which every part of the body is built up and repaired. They

also help supply heat to keep the body warm. In fact, the proteids are the most important of all the food stuffs.

82. The Starches and Sugars. — The **starches** and **sugars** form a large part of the plants commonly used as food. Wheat, barley, rye, oats, rice, corn, arrowroot, sago, and potatoes are rich in starch.

We might, perhaps, think that all our sugar comes from sugar cane and beets, and must be bought of the grocer; but this is not the case. There is a little sugar in wheat, and a great deal in some other things we eat, such as peas, oatmeal, honey, milk, ripe bananas, grapes, and watermelons.

83. How Starch is changed into Sugar. — When starch is well chewed it is changed into sugar by the action of the saliva. This is why a piece of bread tastes sweeter after it has been in the mouth for a few minutes.

Some people like the crust of bread, or the heel of a loaf, especially if it is soaked in milk or tea. Why? Because it is sweet; and it is sweet because, having been baked hard, the starch has been partly changed into sugar.

We seldom, however, keep food in the mouth long enough to change all the starch into sugar. This is done further along in the process of digestion, as we shall learn later.

The chief use of the starches and sugars is to build up the body and help keep it warm.

84. The Fats. — Some people, especially children, do not like **fat**; but we all need fat in one form or another. One of the best ways of getting this kind of food is to use cream and butter with the foods that need them. Other fatty foods are olive oil and some of the fatty meats. Fat is chiefly a heat-giving food.

85. Fat as a Favorite Article of Diet. — Fatty foods are much used by people who live in cold countries. The Eskimos eat large quantities of blubber. The children of the far North, it is said, have as keen a relish for tallow candles as our boys and girls have for ice cream.

Sir John Franklin once tried to find out how much fat an Eskimo boy would eat. Several pounds of candles quickly disappeared, and Sir John, feeling alarmed for his stores, closed the experiment with a large piece of fat pork.

Oil is a luxury greedily devoured by the northern races, as was amusingly proved in a French seaport town many years ago. The town was lighted with whale-oil lamps, and it was noticed that they went out early for several successive nights. At last it was discovered that some Russian sailors in the harbor climbed the lamp-posts and drank the oil.

86. The Mineral Foods. — All the foods we have just studied come from living things, as animals and vegetables. Besides these, we eat certain things which are called **mineral foods.**

First of all, **water** is a mineral food; but this will be described more fully in Section 89.

87. Common Salt. — We cannot do without common **salt** as an article of food. The lower animals like it too. Farmers put lumps of salt in their fields for the sheep and cows to eat. Cattle are fond of the salty taste of the coarse grass which grows on the marshes near the seashore.

The early settlers of Kentucky followed the well-beaten trails made by thousands of buffaloes as they tramped to and fro for many years through the vast wilderness to the salt licks.

Men have risked their lives to get even a taste of salt. In olden times prisoners were punished by feeding them on bread alone, and that made without salt. In most countries it is plentiful and cheap, while in others it is very hard to get. Cakes of salt have even been used for money.

Salt has always been the symbol of life, hospitality, and wisdom; and the Scriptures tell us, "Salt is good. . . . Have salt in yourselves, and have peace one with another."

How much salt do you suppose we have in our bodies? About half a pound, it is said, but we are all the time getting rid of it. The sweat, we know, contains salt; and it is also found in the tears. Even if we did not add salt to our food we should still get some, for many of the things we eat, as meat, oatmeal, and cheese, contain a little of it.

88. Some Other Salts. — We need other salts to help keep our bodies in good order. Except common salt and water, mineral substances are used only when combined with other foods. These are chiefly the salts of potash, found in various vegetables and fruits. Years ago sailors who were forced to go on long voyages without fresh vegetables often died from a dread disease called *scurvy*. Now that vessels are able to carry various canned and bottled goods the disease is less common.

Everybody, but especially a growing child, needs salts of lime to make the bones harder and stronger. One reason why children should eat plenty of bread and milk is that those foods contain these salts.

Should you think that we need any iron in our food? Well, we *do*; for iron helps to make good blood and to give it a bright red color. Iron in small amounts is found in many of the foods we eat. It is said that there is as much iron in the whole body as there is in four carpet tacks.

89. Water as a Food. — Pure **water** is our great natural drink. Many savage nations know no other drink, and require no other. Not only is the greater part of our drink water, but bread, meat, potatoes, fruits, and other foods also contain water, which makes them easy to digest. Nearly three fourths of the weight of our body is made up of water. How important it is, then, to have the water we drink pure and fresh!

The body is all the time getting rid of a great deal of water — nearly two quarts every day — through the skin, the lungs, and the kidneys; hence we must take in water every day besides what we drink, to make up for this loss.

Certain foods, as lettuce, cabbages, apples, fish, potatoes, and lean meat, are more than three fourths water.

Water alone will prolong life for a time if nothing else can be had. Men have succeeded in living forty days or longer without taking any other food or drink than water. There is a well-known case of a miner who lived twenty-three days buried in a coal mine, without swallowing anything but water, sucked through a straw.

90. Various Kinds of Bread. — Bread is "the staff of life." Without it we should indeed be poorly off. There is no single food which meets so many real wants of the body as does **bread.** It is made from the flour of many kinds of **cereals,** such as wheat, oats, barley, rye, and Indian corn. In our country it is nearly always made from corn and wheat.

Wheat flour contains starch, sugar, and a kind of proteid — the sticky or gluey part of grain — called *gluten.* Wheat contains nearly everything necessary to give warmth and strength to our bodies, except fat. When we eat bread and butter and drink milk with them we are using most wholesome and nutritious articles of diet.

91. Other Cereals and Fruits. — Corn meal is a highly nutritious article of food. So is oatmeal and milk.

Coffee and tea are hurtful for boys and girls. Doubtless everybody would be in better health without using these two popular drinks.

95. Ice Water and Other Drinks. — We sometimes see people, overheated and overtired, drink large quantities of **ice water.** Such a foolish practice often leads to serious results. Ice water should be sipped slowly, a little at a time.

Men who are obliged to work in very hot places, as boiler rooms and foundries, get great relief from the intense heat by drinking a mixture of oatmeal and cold water.

There are many kinds of popular drinks exposed for sale, especially during hot weather. They are usually made of water flavored with fruit syrups, roots, and herbs, and slightly charged with carbonic acid gas. They are commonly known as soda waters. These drinks are refreshing, and when used with good sense have no ill effects. Root beers which are made with yeast and fermented contain alcohol and for that reason are to be avoided.

QUESTIONS FOR REVIEW

1. If we compare the body to a locomotive, what part does food play?
2. What two things must the body, as well as the engine, have to keep it in running order?
3. How are our bodies working and wasting all the time?
4. Why do not our bodies waste away?
5. What are some of the wonderful changes made in the food we eat?
6. What, in a general way, must the body have for its food?
7. What are the four great classes of foods?
8. What are proteids, and what are their chief kinds?
9. What want do the proteids supply?
10. From what class of plants do we get the starches?
11. What plants supply us with the sugars?
12. What do the starches and sugars supply the body?
13. How do we get our supply of fats?
14. With what peoples are fats a favorite article of diet?
15. What examples can you give to illustrate this fact?
16. What do the fats supply the body?
17. What are mineral foods?
18. What can you tell of the use of common salt as a food?
19. What other forms of salt do we need as food?
20. What can you say of water as an article of diet?
21. What are the various kinds of breads used as food?
22. Mention other cereals and the more common fruits and vegetables that supply us with a variety of food.
23. How are meat, fish, and poultry used as food?
24. What are some of the ill effects of drinking tea?
25. What cautions can you give as to the use of ice water and other drinks?

CHAPTER VI

ORIGIN AND NATURE OF FERMENTED DRINKS

96. Sweet Apple Juice. — When the juice of apples is first pressed out it is sweet. A kind of sugar forms in apples while they are ripening. This gives the juice its sweet taste. Very soon after the apple juice is pressed out, unless it is kept very cold or boiled and sealed in air-tight jars, it begins to change and to lose its sweetness. Why? Because the sugar of the juice is being changed into something which is not sweet, but strong and poisonous.

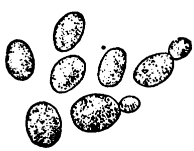

FIG. 55.—Yeast from a Dried Yeast Cake

97. Yeast. — What causes the apple juice to change? It is something so small that it can be seen only by the aid of a microscope.

You have all seen the yeast that is used in making bread. You would not think it, but **yeast** is really composed of many very tiny plants. Similar tiny plants, called *wild yeast*, are found in the air and on the skins and stems of fruit. When the apples are ground and pressed some of these wild yeast plants are washed into the juice. If our eyes were strong enough, we might see them on the outside of the apples before they are

ground, or floating about in the air ready to fall into the juice as soon as it is pressed out.

98. What happens to the Yeast Plant. — A single yeast plant by itself could not do much harm, but when one of them gets into fruit juice in a moderately warm air it begins rapidly to produce new plants like itself. Thus in a few hours after the juice is pressed out, countless numbers of yeast plants will be found in it. Each of these soon puts out little buds that quickly become new plants, while at the same time they change the sugar of the juice into two substances entirely different from sugar.

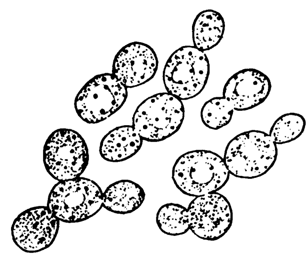

FIG. 56. — The Same Yeast after a Few Hours' Growth

The **gas** which you can see coming up out of the liquid in little bubbles is one of these substances; the other is **alcohol**. You do not see the alcohol because it mixes with the apple juice and remains in it.

99. Alcohol a Poison. — What is a poison? When we call a substance a poison we do not mean that it will always kill a person at once if he takes it, nor indeed that it will necessarily kill him at all. We sometimes see a person poisoned by touching the poison ivy plant, or from a bee sting, but we do not expect to see the person drop down dead from the effects. What, then, do we mean by a poison? We mean this:

A **poison** is any substance which, when absorbed into the blood, will injure health or destroy life. Alcohol is such a poison.

100. Alcohol contrasted with Water. — Alcohol looks like water, but its nature is very different. Water will not burn; alcohol will. Water poured on a plant will cause it to grow and thrive; alcohol poured on a plant will kill it. A fish, which lives all its life in water, would die at once if put into alcohol. Every part of our bodies needs water; we should soon die if we could not get it. No part of the body needs alcohol; thousands of people are made ill or die every year from taking the various kinds of intoxicating liquors into their bodies.

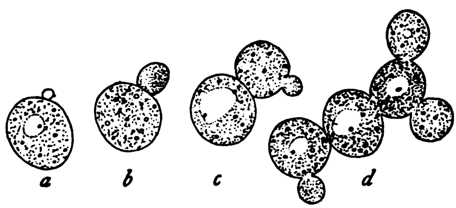

FIG. 57. — Growing Yeast Cells, showing Method of budding and forming Groups of Cells

Each bud appears as a little swelling on the side of the larger cell, as seen in *a* and *b*. In *c* the little bud has grown to be nearly as large as the parent cell. The little buds grow one after another, making irregular shaped groups, as shown in *d*

Water softens our food and helps to digest it; alcohol hardens many kinds of food. Water soothes and refreshes the body, outside and inside. Alcohol inflames and irritates the delicate tissues of the body. Water quenches thirst; alcohol creates thirst. It is the nature of alcohol to arouse in one who takes it a desire for more.

Experiments. — Into a common test tube or any glass vial place a solution made by mixing one teaspoonful of molasses with ten teaspoonfuls of water. Rub up a little compressed yeast in water and put a few drops into the test tube. Set aside in a warm place and let it stand for about twenty-four hours. At the end of this time a vigorous fermentation will be seen. The liquid will have become somewhat cloudy, numerous bubbles can be seen rising through it, a froth forms on top, and a mass of sediment soon collects at the bottom. The bubbles are the gas (carbon dioxide) which is escaping into the air, the sediment at the bottom is the growing mass of yeast, and the alcohol, which looks like water, is dissolved in the liquid and is of course invisible.

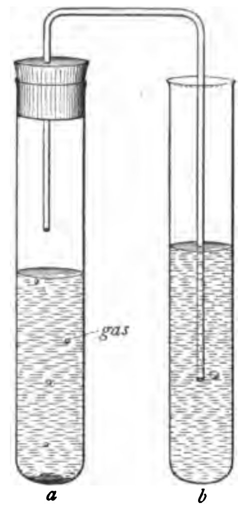

FIG. 58. — Fermenting Solution of Molasses

Showing at *a* the growing yeast with the bubbles of gas arising, and also the arrangement for conducting the gas underneath limewater at *b*, for the purpose of determining the nature of the gas

Prepare two tubes, as shown in Fig. 58. In tube *a* place molasses and water with several drops of yeast, as in the last experiment. Put the cork in place and insert the other end of the tube into a second tube underneath the surface of some clear limewater, as shown in the figure. Set aside in a warm place until vigorous fermentation occurs. Note the bubbles of gas that arise from the fermenting tube and bubble up through the limewater. The limewater soon becomes turbid, showing that the gas contains carbon dioxide. — CONN'S *Bacteria, Yeasts, and Molds*, p. 274.

101. The Appetite for Alcohol. —

Alcohol has the power to create an **appetite** which will lead a man to sacrifice his health, property, ability to work, the respect of his friends, and everything that makes life worth living.

This appetite or craving for alcohol is not like the ordinary appetite for food. The appetite for food is a natural appetite. When enough food is taken to supply the wants of the body for the time, the appetite is satisfied. The same is true of thirst. When enough water is drunk to supply the need of the body in health, no more is wanted. Alcoholic drink taken to satisfy the appetite for alcohol usually causes a craving for more.

102. The Alcohol Habit. — Men who have devoted years trying to rescue those who have become victims of the appetite for alcohol say that, with all their efforts, only a few are finally saved. Men who have abstained for months, or even years, may be suddenly overpowered by the slightest taste or even the smell of alcoholic drink.

Drunkenness is due more to the nature of the drink than to the weak will of the drinker. The greatest weakness of the drinker is in beginning to take the drink that has the power to make him its slave.

103. Alcohol as a Flavoring for Food. — It is the custom of some housekeepers to use wine or brandy as a flavoring for jellies, pudding sauces, mince pies, and other delicacies. Knowing the nature of alcohol, it is easy to see the dangers of such a practice. It may create a taste for alcoholic drinks, or increase the appetite in one who is trying to overcome it.

104. The Law of Fermentation. — We have seen how the yeast plant changes sugar in a sweet fruit or plant

juice to alcohol. This process is called **vinous fermentation**, and the tiny plants that cause it are sometimes called **ferments.** There are other kinds of fermentation produced by other kinds of ferments. Each fermentation has its special kind of ferment, but one law holds good for every kind. It is this:

Fermentation changes the nature of the substance fermented.

Thus, if cider is left standing in a warm place, another kind of ferment gets into it and changes the alcohol into a new substance, entirely different from alcohol or sugar. This new substance is acetic acid, and the liquid containing it, which was first sweet apple juice, and then cider, is now vinegar.

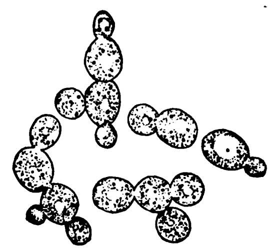

FIG. 59.—Wild Yeast Plants, or Ferments, found in the Juice of Apples, and which cause the Fermentation of Cider

105. The Evils of Cider Drinking. — The fermented drink made from the juice of apples is called **cider.** When the juice is first pressed out it is said to be "sweet cider." As it grows older, more and more alcohol forms in it, and it is then said to be growing "hard." Hard cider may contain as much as one tenth alcohol.

A mistaken idea very commonly held is that cider only a few days old contains such a very small quantity of alcohol as to be practically harmless. Experience proves

that even such cider often has enough alcohol in it to arouse the thirst for stronger drinks in one who is trying to break off from their use, or to cause a liking for alcoholic drinks in one who has not formed the habit of taking them. In moderately warm weather alcohol is found in cider in about six hours after it has been pressed out. We need not go far to find those who have been led to indulge in strong drink by cider. A little alcohol in cider or in any other drink may create an appetite for more. A marked trait of habitual hard-cider drinkers is a tendency to a surly and irritable disposition.

106. Wine a Dangerous Drink. — Ferments, or wild yeast plants, are found upon the skins and stems of grapes as they ripen. If the juice of the grapes is then pressed out, the yeast plants are washed into it, and turn the sugar of the juice into gas and alcohol. The gas will escape in bubbles, while the alcohol will remain in the liquid. Such a liquid is called **wine.** We do not see the alcohol in the wine; but it is there, and can be separated from it, as we shall soon learn. We can also trace its presence by its effects upon those who drink the wine. The alcohol in wine, like that in cider, is capable of creating an appetite for more.

107. Wine Drinking in Foreign Countries. — In Persia, France, Switzerland, and other countries where wine is made, drunkenness is a great scourge, especially during the wine-making season. It has been claimed that

the use of "light wines," i.e. wines containing only a small amount of alcohol, prevents drunkenness; but in countries where such "light wines" are almost as free as water, the evils resulting from their use show that there is little or no foundation for such a claim.

108. A Common Error. — It is a common error to suppose that, because grapes are good, the drink made by fermenting their juice is also good. We have learned that fermentation changes the nature of the substance fermented. Vinous fermentation changes healthful grape juice into harmful wine by changing its sugar, which is a food, into alcohol, which is a poison.

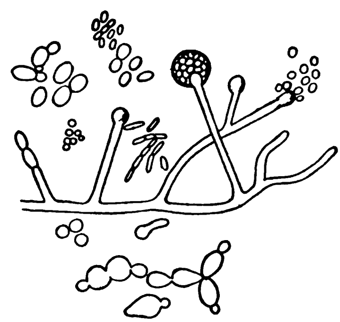

FIG. 60. — Wild Yeast Plants, or Ferments, found upon the Skin of a Grape, which are concerned in the Fermentation of Wine

109. Malt Liquors. — Fermented drinks containing alcohol are made from liquids having in them a certain kind of sugar like that in fruit juices. This kind of sugar can be obtained from starch by keeping the latter warm and moist for a certain time. Barley and other grains containing starch are therefore used to make one kind of fermented liquors called **malt liquors.**

110. How Malt Liquors are made. — In making malt liquors, barley or whatever grain is used, is kept warm

and moist until it begins to sprout, showing that its starch has turned to sugar.

It is then heated to kill the sprouts, ground, and soaked in water; and in this way a sweet liquid is obtained. Yeast, which is one kind of ferment, is then put in, with hops, which give the liquid a bitter taste. The yeast changes the sugar of this grain juice to alcohol and a gas. The gas bubbles up to the top, where it leaves a froth. The alcohol remains in the liquid, which is now called **beer.**

111. Dangers of Beer Drinking. — Beer is used as a drink by many people who do not understand its real nature, or who have learned its nature only after having formed such a liking for it that they cannot easily give it up. It has been called "liquid food" because it was thought that the substances which make the grain good for food remain in the beer. But, as we have seen, fermentation changes the nature of the sugar obtained from the starch of the grain; and in this change nearly all the food value of the grain is destroyed and alcohol is left in its place. The man who eats the bread he could buy for the price of a glass of beer, and drinks pure water, gets real nourishment and no poison, while if he drinks the beer, he gets little or no nourishment and some poison.

112. Beer gives a False Appearance of Health. — The beer drinker's appearance is often as deceitful as his

drink. He looks plump and rosy, as if he were in perfect health; but a little unusual exertion often brings out weaknesses which the perfectly healthy man does not show. The commander of one of the United States army posts said recently: "Several times within the last ten years I have noticed, when extra and continuous exertion has been required in marching, that in every instance the first men to drop out of the ranks and fall by the wayside have been the beer drinkers."

113. Beer No Preventive of Drunkenness. — It has been urged that a more general use of beer would prevent the drunkenness caused by drinking the liquors that contain more alcohol, such as rum, whisky, brandy, and gin. We have only to look to the countries where beer is used in nearly every family, to see that it is no preventive of drunkenness. True to its nature, the alcohol in the beer makes the drinker crave more beer to get more alcohol. In certain countries of Europe where beer and wine are almost universal beverages, the disastrous effects of alcohol upon the health of the people are becoming more and more apparent.

114. Beer Drinking from a Moral Point of View. — Facts gained from wide observation seem to show that the habitual use of large quantities of beer tends to deaden the conscience and blunt the finer sensibilities of the drinker.

The fact that beer contains less alcohol than some other drinks is no argument in its favor when we

remember that the alcohol in even the weakest beer may have the same power of creating an appetite for more that an equal quantity of alcohol in any other liquor has. The drinker is liable to be tempted by the weakness of the beer to increase his amount, thinking it is comparatively harmless.

115. Fermentation in Bread Making. — Fermentation is generally employed in making bread. The flour from which the bread is made contains a small quantity of free sugar. Yeast is mixed with the flour and water, and the dough is kept warm and moist until the yeast changes this free sugar to alcohol and gas. But the fermentation is soon stopped and the alcohol is driven out by the heat of the oven in which the bread is baked, while the gas, pushing its way up through the dough, makes the bread light. To get this light sponginess is the purpose for which the yeast is used.

Thus no one needs to be afraid to eat bread raised with yeast, through fear of its containing alcohol, for well-baked bread contains no alcohol. We may be sure that bread never gave anybody an appetite for strong drink.

116. Distilled Liquors. — When water is heated to a certain temperature it begins to turn into steam. How often do children watch the steam as it escapes from the nozzle of a boiling teakettle and floats away as vapor to cool off as drops of water on the cold window glass!

Alcohol will turn to vapor at a lower temperature than water. Therefore, by heating a fermented liquid the alcohol in it can be readily driven off in the form of vapor. This is condensed in a cool receiver, and the result is a liquid containing much more alcohol than the one heated. Some water will follow the alcohol, for alcohol has a special liking for water.

The process by which one liquid is separated from another by changing it into vapor by heat and afterwards condensing the vapor with cold is called **distillation.**

The liquids which are obtained by this process are known as **distilled liquors.**

Brandy is distilled in this way from wine; rum is distilled from the fermented juice of the sugar cane; whisky, from a fermented liquid usually made from corn or rye; gin, from rye or barley. All distilled liquors contain a large proportion of alcohol, often as much as one half. Some distilled liquors may be made from wood, wine, or beer; others, from fermented tomatoes and corn; but they are all alike in one very important respect,— they are all **narcotic poisons.** They are therefore capable of causing a far-reaching and baneful effect upon the health of those who have become addicted to their use.

QUESTIONS FOR REVIEW

1. What is meant by sweet apple juice?
2. What change takes place soon after the juice is pressed out?
3. What causes the changes in the pressed-out fruit juices?
4. What is yeast?
5. Where are the yeast plants before the apples are ground?
6. Explain the action of yeast plants upon fruit juice.
7. Define a poison.
8. Mention the main points of contrast between alcohol and water.
9. What is meant by the alcohol appetite?
10. How does it differ from a natural appetite?
11. What proves the strength of the alcohol appetite?
12. What dangers may arise from the use of alcohol as a flavoring in cooking?
13. What is the law of fermentation?
14. How is this illustrated when cider changes to vinegar?
15. What are some of the evils of cider drinking?
16. What changes the nature of the grape juice when wine is made?
17. Why is wine a dangerous drink?
18. How does the use of wine in foreign lands illustrate this point?
19. Explain how beer is made.
20. Show how the law of fermentation applies to the process of beer making.
21. What are the dangers in drinking beer?
22. How may beer drinking show its effects upon health?
23. What can you say of beer drinking from a moral point of view?
24. Show how bread is made by fermentation.
25. What are distilled liquors? Mention some of the more common kinds.

CHAPTER VII

DIGESTION, AND HOW IT GOES ON

117. What is meant by Digestion.—The blood not only carries food to every tiny part of the body to make up for the wear and tear, but it also brings back waste matter from nearly every nook and corner.

It is plain that the blood could not go on feeding the body unless it were itself nourished from some source outside of the body. This is done, for the most part, by what we eat and drink.

In other words, the nourishing portion of our food, after it has gone through many changes, becomes at last a part of the blood.

118. The Organs of Digestion. — This wonderful process by which food is made ready to become a part of the blood is known as **digestion.**

Those parts or organs of the body which have to do with bringing about this magical change in what we eat and drink are called the **organs of digestion.**

It will make it easier for us to learn a few things about digestion if we study it in its three great steps,— namely, those which take place in the **mouth**, in the **stomach,** and in the **intestines.**

119. What takes Place in the Mouth. The Teeth. — The food is broken into pieces in the mouth by the **teeth**, — valuable little jewels, of which we cannot be too careful.

During our lifetime we have two sets of teeth. The first set, twenty in number, begins to appear when a child is about six months old. A child may even be born with teeth.

FIG. 61. — The Temporary and Permanent Sets of Teeth

Milk, or *Temporary Teeth:* *A*, central incisors, or cutting teeth; *B*, lateral incisors; *C*, canines, or dog teeth; *D* and *E*, molars

Permanent Teeth: *F*, central incisors; *H*, lateral incisors; *K*, canines; *L*, first bicuspids; *M*, second bicuspids; *N*, first molars

It is said that Louis XIV, a king of France, Richard III, a wicked king of England, and Mirabeau, a famous French orator, were born into the world with teeth.

When a child is about six years old the first set, commonly called the **milk** teeth, begins to decay; and the second, or **permanent** set, thirty-two in number, gradually takes its place.

Each tooth is firmly set in a socket in the jawbone. The teeth are chiefly made of *dentine*, an ivorylike

substance, coated with a thin layer of a harder substance, called *enamel.* Inside of each tooth is a space filled with a delicate substance called the *pulp*, well supplied with nerves and blood vessels.

When a tooth is decayed, and the nerve is open to the air, it soon begins to ache. This is one reason why we need to take great care of the teeth, as we shall learn later.

Experiments. — Each pupil should locate his own teeth with the aid of a mirror. The teacher may point out the incisors, bicuspids, and molars. Study also the teeth of some schoolmate.

Get a dentist to give you specimens of the various kinds of teeth. The teacher may show a perfect molar tooth which has been sawn in two lengthwise and describe its various parts.

The pupil may prepare a blackboard sketch of a tooth on a large scale, using colored crayons to make plain its various parts. (Fig. 71.)

120. Mixing the Food with Saliva. — While the food is being crushed and ground into fine pieces by the teeth, it is rolled about by the tongue, pressed against the cheeks and the roof of the mouth, and then swallowed.

During this time the food is well mixed with the fluid of the mouth, called **saliva**, which flows from a number of little spongy organs called **salivary glands.**

Perhaps you have had "mumps," or at least have seen some friend who had them. In this disease two of these little organs, one under each ear, become inflamed and swollen for a few days.

121. The Work done by the Saliva. — The saliva wets the food, and so makes it easier to swallow. It has,

besides, another important work to do: it acts on the starchy part of the food, changing some of it into sugar.

We know that a piece of bread grows sweet in the mouth when it is well wet with saliva. This work of the saliva is important, for unless starch is changed into sugar, it can do us no good.

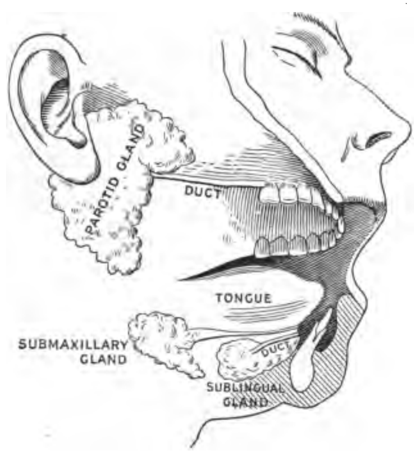

FIG. 62. — BLACKBOARD SKETCH
Salivary Glands of the Right Side

When we are not eating, the saliva flows only in small quantities, just enough to keep the mouth comfortably moist; but when we begin to eat, the glands that make saliva do a brisk business, and pour into the mouth a large quantity, about half a pint, it is said, at a single meal.

122. What will make a Change in the Flow of Saliva. — The sight, or even the thought, of a savory dish will make the saliva flow, or, as we say, "make the mouth water." The sight of a piece of meat may make the saliva run out of a hungry dog's mouth.

Smoking or chewing tobacco or chewing gum causes an undue amount of saliva to flow, thus overworking the glands.

The constant spitting of tobacco juice wastes the saliva needed to digest the food, and after a time it may have an ill effect on digestion.

Fear may stop the flow of saliva; hence in India they sometimes try to detect a thief by making those who are suspected chew uncooked rice. The person from whose mouth it comes out driest is judged to be the thief.

We can easily understand how necessary it is to chew our food well before we swallow it. If we eat very fast, and bolt our food nearly whole, we get little good from it. It does not digest easily, and sooner or later we shall suffer for our negligence.

Experiments. — A simple experiment may illustrate the action of saliva on starch. Chew slowly a piece of fresh bread or cracker. Note the sweet taste after the food is well moistened with saliva. Repeat the experiment with a mouthful of cool paste made by stirring arrowroot (almost pure starch) into boiling water.

If the finger or a lead pencil be moved gently to and fro in the mouth a few times, the saliva will flow freely. Think of some favorite article of food and notice the abundant flow of saliva.

123. How the Food is swallowed. — The soft, moist mass is pushed into the back of the mouth, and forced down the **gullet**, or **food pipe**, by a wavelike motion. If you watch a horse's neck when he is drinking you will see this motion.

Another hollow tube in front of the food pipe opens into the back of the mouth. You know it is as necessary to breathe air into our lungs as it is to take food into our

stomach. So this other tube, or **windpipe** as it is called, is for the passage of the air to the lungs.

If food should get into the windpipe instead of into the food pipe, we might be choked. We all know that when a bit of food goes "the wrong way" we have to cough until we get it up.

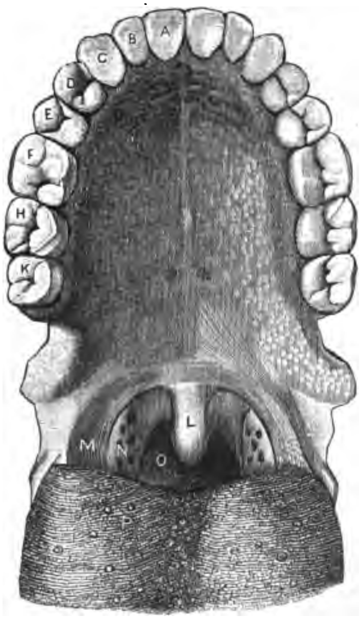

FIG. 63.—A View of the Back Part of the Adult Mouth. The Head is represented as thrown back, and the Tongue drawn forward

A, *B*, incisors, or cutting teeth; *C*, canine, or dog teeth; *D*, *E*, bicuspids; *F*, *H*, *K*, molars; M, anterior pillar of the fauces; *N*, tonsil; *L*, uvula; *O*, upper part of the pharynx; *P*, tongue drawn forward

124. The Little Trapdoor known as the Epiglottis.— Now you must know that in order to prevent food from slipping into the windpipe, the latter is protected by a little trapdoor.

A very clever fellow is this trapdoor. When we are just about to swallow a morsel of food, down goes the trapdoor quick and tight, and keeps the food out of the windpipe; but as soon as the food is down, up again flies the trapdoor, to let air pass down to the lungs. This wonderfully useful little servant is called the **epiglottis**, meaning, "upon the tongue."

125. The Stomach.—The food, a moistened, partly digested mass, has now reached the stomach.

The **stomach** is a pear-shaped bag, capable of holding a quart or more. It lies across the upper part of the abdomen, a little toward the left side.

The size of the stomach depends somewhat upon how much there is in it. As we fill it with food it swells out larger, like a toy balloon, which becomes, as every child knows, smaller or larger according to the amount of air in it.

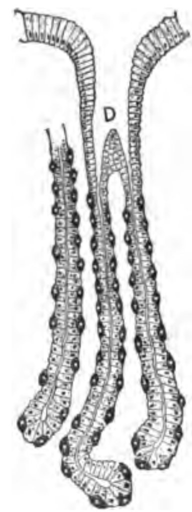

FIG. 64.—Diagram of a Gastric Gland. (Highly magnified)

The cells of the surface are represented as dipping down into the duct, *D*, of the gland, from which two tubes branch off

126. The Two Openings of the Stomach.—The stomach has two openings,—the gullet end, through which the food enters, and the outgoing end, a kind of muscular ring. This outgoing end, called by a name which means the "gate keeper," is made in such a wonderful manner that any food trying to get through too soon is sent back.

Would not that carpenter be called a very clever man who could make a door which would open and shut of itself at the right time, which would let only the right sort of people go out, and which would crowd away the wrong ones?

127. What takes place in the Stomach. — As we begin to eat, the walls of the stomach stretch themselves out to make room for the food, and begin to move gently with a wavy motion, which carries the food round and round as if it were being churned. This churning motion is slow and gentle at first, but becomes faster as digestion goes on.

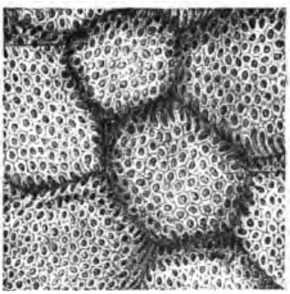

FIG. 65. — The Inner Surface of the Stomach, from which the Lining of Cells has been removed, showing the Openings of Gastric Glands

As soon as the food arrives in the stomach, thousands of tiny holes in its walls pour out upon it a fluid called the **gastric juice.** This flows in great abundance, — several quarts, probably, every day, — and has in it a peculiar substance called *pepsin*, which is necessary to the digestion of food in the stomach.

The gastric juice dissolves, and thus helps digest, such foods as have proteid in them, as lean meat, milk, eggs, and some parts of bread.

A part of the contents of the stomach, being easily dissolved, and soon sufficiently digested, does not go any farther, but passes at once into the blood.

128. How Some Parts of the Food get into the Blood from the Stomach. — The way in which digested food gets from the stomach into the blood is very curious. All over the inside walls of the stomach are thousands

of the tiniest blood vessels with very thin walls. Certain parts of the digested food soak out of the stomach through these very thin walls into the blood vessels, and so reach the blood. The parts of the food which need further digestion pass into the upper part of the small intestine.

If we could see all these wonderful things going on inside of our stomachs, it would be more instructive than watching the bees make honey through the glass windows of their hives.

It is very plain that the stomach has a great deal of hard work to do. It is a busy workshop, where all that is eaten is partly made ready for the use of the body. It was a favorite saying of Frederick the Great that "an army moves on its stomach."

Experiments. — The teacher may prepare artificial gastric juice for experimental purposes by dissolving about ten grains of pepsin powder (obtained of any druggist) in half a pint of water and adding perhaps from fifteen to twenty drops of strong hydrochloric acid, or about six times as much of the dilute acid.

To show the action of gastric juice on milk, pupils may mix two teaspoonfuls of fresh milk with a few drops of artificial gastric juice, and keep at about 100° F. In a short time the milk curdles so that the tube can be inverted without the curd falling out.

Obtain at the market a small piece of a pig's stomach. Its wall closely resembles that of the human stomach. Scrape off the inner coat with the edge of a sharp pocket knife. Use a strong magnifying glass to find the openings of the gastric tubes. With the help of fine needles, pick away the layers until the fibers of the muscular coats are found.

129. How the Small Intestine does its Work. — When the food has been properly prepared in the stomach, the gate keeper opens the gate for the partly digested food to pass out into the long tube known as the **small intestine**, or the bowels.

This tube is about twenty-five feet long, but it is so folded and coiled in the body that it takes up very little room.

130. Two Important Digestive Fluids. — In the first twelve inches of the small intestine the food is mixed with two fluids which flow into it through two little tubes.

The one, called **pancreatic juice**, is made by the pancreas, or sweetbread as we call it in animals. The other is a greenish-yellow fluid, called the **bile**, which is made in the liver.

The **liver** is the largest organ in the body, and weighs about fifty or sixty ounces. It is on the right side and in the upper part of the abdomen.

131. The Bile. — The bile is stored up in a little pear-shaped bag attached to the liver, called the *gall bladder*. This little bag is ready to do its part in the twinkling of an eye when the food enters the small intestine, and straightway pours out its bitter fluid.

The next time the cook cleans a fowl ask her to show you the little greenish bladder, which she takes care not to break, because it holds a bitter fluid which, if spilt upon the fowl, would quite ruin its flavor.

132. The Liver as a very Busy Workshop. — The liver is a very busy workshop; in fact, it does double duty. It makes out of the waste matter of the blood the bile which is so necessary to our health.

Again, the liver is a storehouse, in which is laid up a kind of sugar which is gradually doled out to the blood as it is needed for the use of the body.

The fat we eat is not digested in the mouth or stomach, but in the small intestine. The bile divides the fat into very small particles, and fits it to be taken up by the blood.

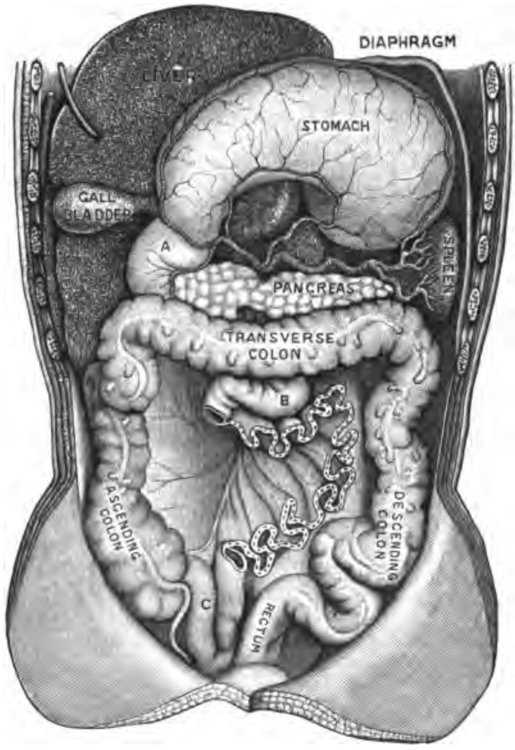

FIG. 66.— Showing the Relations of the Stomach, Liver, Intestines, Spleen, and other Organs of the Abdomen. (Front View)

A, first part of the small intestine, or duodenum; *B*, upper end of the small intestine; *C*, lower end of the small intestine. The liver and stomach are drawn up. Portions of the small intestine have been cut away, showing parts of the large intestine

The fluid from the pancreas also aids in the digestion of fat. This with other fluids finishes the digestion of the starchy foods not already changed into sugar by the saliva, and carries on the digestion of other foods which the stomach has failed to complete.

133. How the Food gets into the Blood. — Now that the food has been acted upon by the digestive fluids and has become a thick, creamy mass, it remains for us to see how the rich, nutritious part gets into the blood.

This is done chiefly by two sets of vessels, — the **blood vessels**, and the **lacteals** or **lymphatics**.

The process by which the digested matters are taken into the blood is called **absorption.**

134. Absorption by Means of the Blood Vessels. — The inner lining of the small intestine is richly supplied with blood vessels. Certain parts of the food which were not digested in the stomach readily soak through the delicate walls of these vessels and are taken directly into the blood.

135. Absorption by the Lacteals. — The inside lining of the intestines is not smooth, like the outside, but has a velvety appearance. Millions of short threads, called *villi*, meaning "tufts of hair," hang down like very small tongues into the inside of the small intestine.

The villi are only about one thirtieth of an inch long, and a five-cent coin would cover five hundred of them. They have the look of the pile on plush. We are familiar with this appearance in tripe.

In each one of these villi is a network of the finest blood vessels, and a tube called a *lacteal*, meaning "milky," because it carries a white, milky fluid. Millions of these **lacteals** dip down into the intestines like little root fibers, and soak up the fatty matters of the food. The droplets of fat give the liquid its creamy or milky appearance; hence the name "lacteals."

FIG. 67. — A Small Portion of the Lining Membrane of the Small Intestine. Villi are seen surrounded by the Openings of the Tubular Glands

136. The Thoracic Duct. — The lacteals, after passing through a number of glands in the abdomen, unite into larger tubes. The largest is a tube from fifteen to eighteen inches long and about as large as a lead pencil, called the **thoracic duct.** This tube carries the fluid upward in front of the backbone, and pours it into a large vein which carries it to the heart.

137. The Lymphatics. — The lacteals are simply those lymphatics which have their roots in the villi of the intestines. In all parts of the body, except in the brain, spinal cord, eyeball, and tendons, we find a wonderful network of thin-walled vessels precisely like the lacteals, called the **lymphatics.** These are busily at work taking up waste or surplus materials derived from the blood and other tissues.

The lymphatics seem to start out of the part in which they are found, like the rootlets of a plant in the soil.

These rootlets join together and make larger roots. They carry a yellowish fluid called **lymph**, very much like blood without the red corpuscles.

At many points in the course of these tubes in which this fluid flows are rounded bodies, called **lymphatic glands**, scattered like stations along a line of railroad. When the hand or arm is injured, the lymphatic glands under the arm often swell and become quite painful.

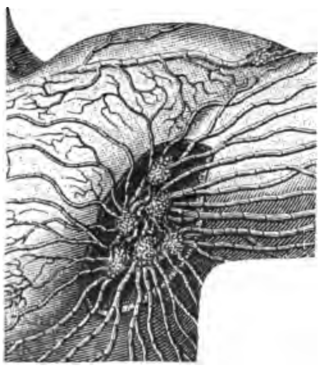

FIG. 68. — Lymphatics and Lymphatic Glands of the Armpit, or Axilla

Most of the lymphatics at last unite with the lacteals and empty their contents into the thoracic duct.

138. The Large Intestine. — The first or main part of the intestines is called the **small intestine**. The last five or six feet of the long digestive tube is known as the **large intestine**. The contents of this portion of the digestive canal travel through it very slowly, and are not much changed while in it.

We may think of the large intestine as a kind of temporary storehouse for undigested and waste matter, which should be got rid of as speedily as possible.

GOOD DIGESTION, AND HOW TO SECURE IT

139. Wholesome Effect of Plain and Simple Food. — The plainest and simplest food is the best to keep us well and strong. It is better for young people to begin a day's work with a breakfast of oatmeal, toast, or well-baked bread, a soft-boiled egg, and a glass of milk, than with one of strong coffee, sausage, and hot bread. One sleeps much better to go to bed after a supper of oatmeal, baked apples, or mush and milk, than after one of hot biscuit, cake, pie, and fried meat.

Do not try to whip up a flagging appetite with an undue amount of pepper, mustard, pickles, and highly seasoned foods. They may spur on digestion for a short time, but will soon weaken it. Much of the discomfort and pain that people suffer comes from putting a great number of things into the stomach that have no business there.

140. The Simple Diet of Some Famous Men. — William Cullen Bryant, the American poet, and one of the hardest literary workers of his time, died from an accident at the age of eighty-four. His daily breakfast was made of hominy and milk, with a little fruit. He ate meat only once a day. For supper he drank no tea, but ate bread and butter and fruit. Yet, when he was over eighty he could do more literary work on this simple diet than most ordinary men of middle age.

Washington was a large and a very strong man. He ate sparingly and of the simplest food. He tells us in his journal that he "breakfasted at seven o'clock on three small Indian hoe-cakes," and that he was "excessively fond of fish."

Even at the state banquets the first President usually dined on a single dish, and that of a very simple kind. When asked to eat some rich food, his courteous reply was, "That is too good for me."

In the days of the Revolution there were backwoodsmen of gigantic strength in the army, and yet Washington was believed to be the most powerful man in the patriot forces. When Sir Isaac Newton was writing his famous classic, called *Principia*, he lived on a scanty allowance of bread, water, and a few vegetables. The great war king, Charles XII of Sweden, said he preferred plain bread and butter to all the rich foods of a royal banquet.

141. The Value of Vegetable Foods.—While most of us eat some kind of meat every day and find it very useful, yet other foods, especially such vegetables as peas and beans, really would furnish the same class of food materials that we get from meat, and would keep us well and strong.

In northern India there are hardy people that live mainly on barley, wheat, millet, and rice. In southern India millions of people live on peas and rice.

The common people of Scotland, among the hardiest men in the world, live largely on oatmeal and milk. The famous Dr. Johnson once spoke of oats as "food for men in Scotland, and for horses in England"; and a sturdy Scotchman added, "Yes, indeed; and where else will you find such men and such horses?"

FIG. 69. — Lymphatics on the Inside of the Right Hand

During the Japanese-Russian war the Japanese soldiers proved themselves to be among the very strongest men on the earth, and yet they ate little or no meat. The diet which enabled them to develop such hardy frames and keen and well-balanced brains consisted almost wholly of rice.

Some of the fierce warrior tribes of South Africa are forbidden by their religion to eat meat. Indian corn with milk is about the only food eaten by the savage Zulus when marching on their long fighting campaigns.

Travelers speak of the tall, stately but thin Arabs in Egypt who pick up and carry off on their heads huge

bales of merchandise. And yet we are told that their diet is chiefly cereals with a little fruit.

142. Peculiar Effect of Common Foods upon Certain Persons. — We have all heard of the old maxim that "what is one man's meat is another man's poison." There is really more truth in this saying than would at first be supposed.

Some persons are made sick by eating certain articles of food which to other people are harmless. Some are made ill by eating various kinds of shellfish, others by eating eggs or fruit.

The story is told of a lady who could digest hard salt beef, but who suffered dreadful pain if she ate a single strawberry; one person was thrown into convulsions whenever he ate onions. Francis I, a king of France, could not eat bread. There are many people who have to avoid apples, veal, and cheese.

143. How the Mind may hinder Digestion. — The state of the mind has a great deal to do with digestion, as it has with every other part of the body.

Sudden fear, or joy, or pain, or any other mental strain may take away the appetite at once and stop digestion. We forget all about the sensation of hunger during a time of mental excitement. Some of us know how hard it is to touch food when stricken with pain or grief. During a battle soldiers will go without food all day, forgetting the rations in their knapsacks.

144. Food and Drink should not be taken too Hot or too Cold. — Do not take food and drink when they are too hot or too cold. If they are taken too cold, undue heat is taken from the stomach, and digestion delayed. If we drink freely of ice water or cold well water, it will take some time for the stomach to regain its natural heat.

Drinking freely of very cold water when the body is heated is also a dangerous practice, and, aside from its ill effects on digestion, has occasionally resulted fatally.

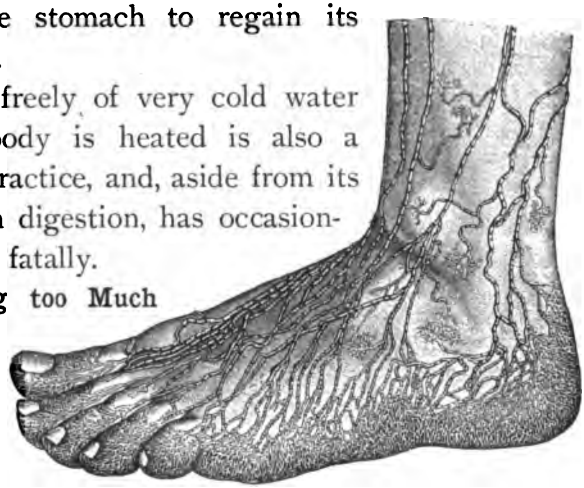

FIG. 70. — Lymphatics of the Left Foot

145. Eating too Much Food. — If we eat too much, we are apt to feel heavy and stupid. An overloaded stomach makes itself felt by a sense of fullness, uneasiness, drowsiness after meals, and sometimes a real distress, like a sick headache. Napoleon Bonaparte claimed that he lost an important battle because of a sick headache which came on suddenly after eating very heartily.

If we keep on eating too much, especially of too rich or highly spiced food, as growing children are apt to do,

the complexion becomes muddy, the face marred with blotches and pimples, and the breath often has an unpleasant odor.

146. Eating at Regular Hours. — The stomach, like other organs, does its work best when its tasks are done at regular periods. Regularity in eating is of the utmost importance. Three meals a day, from five to six hours apart, arranged according to our occupations, should be eaten.

Children should be allowed to eat only at regular times. The habit of eating candy, cake, nuts, or fruit between meals often results in the disorders of digestion which are so common in childhood.

Eating too frequently, as well as too much at a time, may cause indigestion. The stomach is not intended to be constantly at work. After it has done its work it requires a short period of rest. Most articles of food that we eat need from three to five hours for digestion.

147. The Object of cooking Food. — Almost every article of food must be cooked. To be sure, some few things, as milk, eggs, oysters, some vegetables and fruits, are often eaten raw. The chief object of cooking food is to make it more easily chewed and acted upon by the digestive fluids. Cooking brings out agreeable flavors and makes food taste better. The warmth of cooked food has a healthful action. Cooking also kills the little creatures called *parasites*, which are sometimes found in raw food.

148. Girls should be taught to Cook. — Much ill health in families may be traced to badly cooked food. The hardships and discomforts of poverty are often increased by those who have never learned how to buy food wisely and to cook it properly.

No girl has been properly trained for a woman's duties who has not been taught how to buy the family food, to cook it properly, and to serve it well on the table.

149. The Care of the Teeth. — Although the first teeth last only a few years, it is important that they should not be neglected. If they are allowed to decay or to remain in the mouth after they should be removed, they may injure the permanent set or cause the new teeth to grow irregularly.

No pains should be spared to keep the teeth in perfect condition, for misshapen teeth make the mouth unsightly, and unsound ones are, besides, a frequent cause of offensive breath and a foul stomach.

In these days, when dental skill has reached such perfection, there is little excuse for bad teeth. One should not wait for defects to appear, but should let the dentist examine the teeth two or three times a year.

150. Practical Hints about the Teeth. — The teeth should be thoroughly cleansed at bedtime and after each meal with a soft brush and warm water. Some simple tooth powder should be used. The brush should be used on the inner side or back of the teeth as well as on the front.

After eating certain articles of food, as the various sweet stuffs, the mouth is often unwholesome. Hence the teeth should be thoroughly cleansed after eating such food. The sweets stick between the teeth and ferment, thus causing them to decay.

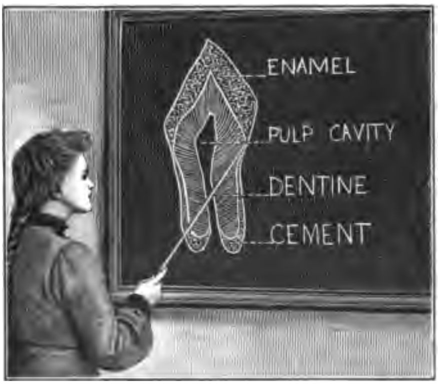

FIG. 71. — Blackboard Exercise on the Teeth

The pupil, having made a blackboard sketch of a section of a tooth, is describing its several parts. (From a photograph taken in the schoolroom)

It is also important to clean the spaces between the teeth and to remove every particle of food. This can be best done by drawing floss silk back and forth between them to cleanse the parts which cannot be reached by a brush.

We must be on our guard lest we do harm to the enamel. For this reason, do not crack nuts, crush hard candy, nor bite off threads with the teeth.

151. How Alcohol may hinder Digestion. — Alcoholic drinks are often taken with meals because they are thought to aid digestion. Like mustard, pepper, ginger, horse-radish, and other irritants, they cause the gastric juice to be rapidly poured out of the walls of the stomach. This may or may not be a good thing.

In the healthy stomach ordinary food and natural appetite cause the stomach to send out enough gastric juice to digest all the food the body requires. Obliging the stomach to provide more gastric juice than is needed is throwing useless work upon an already hard-worked organ of the body.

This is not the only objection to taking alcohol with meals. Alcohol lessens the power of the gastric juice to digest food as long as it remains in the stomach in the amounts ordinarily taken. Gradually, perhaps in half an hour, the alcohol passes out of the stomach, and then the process of digestion can go on. But the time lost must be made up before alcohol can be called a promoter of digestion.

152. Effect of Alcohol upon the Stomach.—The best way to keep good digestion is to eat only as much as natural appetite calls for. If we eat when we are not hungry, or to gratify taste after the desire for plain food is satisfied, and then excite the stomach with alcoholic drinks and other irritants with the idea of making it take care of food that we should not have eaten, we need not be surprised if after a time our stomach gives us pain and trouble.

QUESTIONS FOR REVIEW

1. How is the waste in the blood made good?
2. What is meant by digestion and the digestive organs?
3. What can you tell about the teeth?
4. Describe the process of digestion in the mouth.
5. What is the action of saliva?
6. How do we swallow food?
7. What is the epiglottis, and what is its use?
8. How will you describe the stomach?
9. What takes place when food reaches the stomach?
10. What is the gastric juice, and how does it act?
11. How do some portions of the food get into the blood?
12. Describe the small intestine.
13. What important digestive fluids act upon the food in the intestines?
14. What can you tell about the liver and its work?
15. How is the nutritious part of food absorbed by the blood?
16. Describe the lacteals, and explain their action.
17. What is the thoracic duct, and what is its duty?
18. Describe the lymphatics and explain their work.
19. Describe the large intestine.
20. Describe the effect of eating plain food.
21. What can you tell of the simple diet of some famous men?
22. What races of people have flourished on vegetable foods?
23. What peculiar effect do some foods have upon certain people?
24. How may the mind hinder digestion?
25. Why should not food be taken too hot or too cold?
26. What are some of the ill effects of eating too much food?
27. Why should we eat at regular hours?
28. What are the chief objects in cooking food?
29. Give what hints you can about the care of the teeth.
30. Explain how alcohol may hinder the process of digestion.

CHAPTER VIII

THE BLOOD AND ITS CIRCULATION

153. The Blood: what it is and how it looks. — We all know how blood looks. When freshly drawn it is a bright red fluid, which soon becomes thicker and of a dullish-brown color. After a few minutes it sets to a jelly, or clots as it is called.

Why does blood look red? Because there are in it millions of little red bodies, called **blood cells** or **corpuscles**, which are swept along in the blood current just as you might imagine countless numbers of tiny red fishes swimming in the rapids of a river.

Imagine the clear waters of a brook alive with little red fishes; suppose the fishes to be very, very small, and closely crowded together through the whole depth of the stream, — the water would look red, would it not?

154. More about Blood Corpuscles. — The shape of the red blood corpuscles is somewhat like that of thin round cakes or biscuits. Sometimes they cling together like piles of pennies. In a single drop of blood there are several millions of them; so you see that they are very small and very numerous. They can be seen only with the aid of the microscope.

We are told that these corpuscles are so small that a drop of water no larger than the head of a pin would contain five millions of them. It would take more than three thousand red corpuscles placed side by side to make a line one inch long.

155. The Use of the Red Corpuscles. — Of what use are the **red corpuscles**? All the use in the world. They are very important. They have the power of taking up gases as a sponge can take in water. We shall study in the next chapter something about the oxygen that we breathe in and the carbon dioxide that we breathe out. Now these red corpuscles are the oxygen carriers for the blood; that is, they carry oxygen from the air into every tissue of the body.

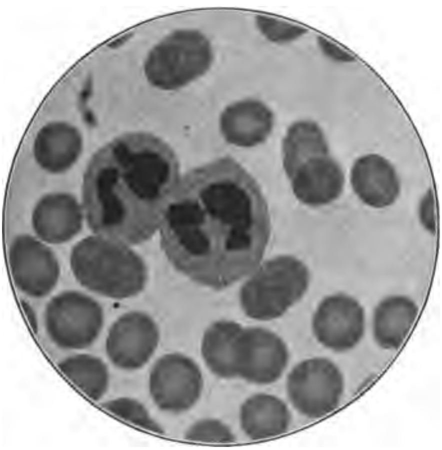

FIG. 72. — Human Blood Corpuscles as seen under the Microscope. (Magnified 1000 diameters)

The dark circular disks are the red corpuscles. Near the center two white corpuscles are seen, with their nuclei stained so that they look black

We may think of them as a fleet of countless little boats, carrying their precious cargoes of oxygen to nearly every part of the body. These corpuscles live a very active

life. Every moment of our lives, whether we are sound asleep or wide-awake, they are as busy as bees.

156. White Corpuscles. — With about every three hundred of the little red corpuscles we can find, with the aid of the microscope, one white corpuscle. These are very different from the red. They have all sorts of queer shapes. While we are watching them they take on new forms as they roll and tumble about in the watery fluid.

FIG. 73. — Blood Corpuscles of the Frog as seen under the Microscope. (Magnified 1000 diameters)

The **white corpuscles** push their way out through the walls of the blood vessels and travel about into various parts of the body. It is believed that they carry off out of harm's way substances which might produce certain diseases if allowed to remain.

157. The Clotting of Blood. — If we beat up ... blood in a bowl with an egg beater, we fin... it a white, sticky substance, which is ea... the coloring matter has been washed aw... called **fibrin.** It is a kind of glue used by n...

bleeding by making a plug for fresh wounds. Were it not for this we might bleed to death from some trifling scratch, from having a tooth pulled, or even from a slight cut.

If we fill a tumbler half full of fresh blood and let it stand over night, we shall find in the morning that it has separated into two parts: one, a sticky, jellylike mass called the **clot**, sinks to the bottom; the other, a straw-colored, watery fluid called **serum**, is on the top. Serum is made up chiefly of a substance similar to the white of an egg dissolved in a great deal of water. It will not boil like water. Before we get it as hot as boiling water it "sets" into a solid mass like the white of a hard-boiled egg. It is the serum which helps feed the tissues of the body with nutritive material.

158. The Circulation of the Blood.—To circulate means to go round, and the **circulation** is so called because the blood goes round and round in the body. The blood is not simply held in our bodies as water is in a sponge; it is carried in pipes. These start from the heart and branch into all parts of the body.

We know we can draw blood from almost any part of the body if we prick it with a needle. In fact, there is hardly a spot on us the size of a needle's point which has not its own little tube filled with blood. Compared with the smallest blood vessels, a needle is a huge stake, and tears not only one but many hundreds of them every time we draw blood with it.

159. Discovery of the Circulation of Blood. — The circulation of the blood was not discovered until a few years before the Pilgrims sailed across the Atlantic in the *May-flower*. The man who made this great discovery deserves

FIG. 74. — William Harvey demonstrating the Circulation of Blood to King Charles the First of England

This picture represents the king as witnessing the dissection of a doe's heart, of which he had placed many at Harvey's disposal while the great physician was making his investigations concerning the circulation of the blood.

(The picture is used by the kind permission of William Wood & Co., publishers)

a few words. His name was William Harvey. He was an Englishman, and a physician to the king of England.

For many years learned men had had a glimmer of light on the subject; but it was Dr. Harvey who put

together all that had been discovered, and really found out the way in which the blood circulates in the human body. The good doctor died in 1657, nearly forty years after his remarkable discovery had been made.

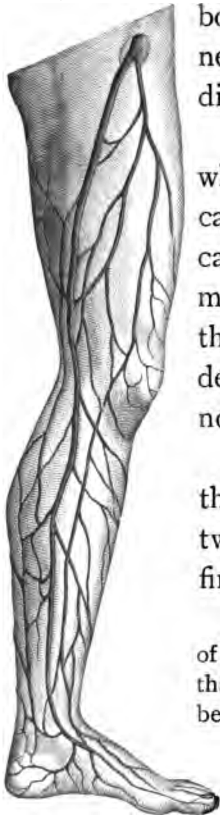

FIG. 75. — The Principal Vein on the Inner Side of the Left Leg

160. The Blood Vessels. — The pipes in which the blood flows *from* the heart are called **arteries.** These are so named because before the time of Harvey learned men, not being able to explain the fact that the arteries were found empty after death, supposed that they carried air, and not blood, throughout the body.

The pipes in which the blood flows *to* the heart are called **veins.** Joining these two sets of vessels is another set of very fine tubes, called **capillaries.**

Experiment. — With the thumb and two fingers of the right hand grasp the left wrist firmly. Note that the blood vessels become prominent. This is because the flow of venous blood towards the heart is checked. The veins have little pouch-like folds, or pockets, which serve to prevent the backward flow of blood. The position of these valves is indicated by the little knots, or swellings, in the veins on the back of the hand.

161. The Capillaries. —The **capillaries** are found almost everywhere. This long name means "hairlike," and to

compare these vessels to hair was probably the best description of their size that learned men could devise. But really our delicate hairs, fine as they are, are cables, and coarse cables too, compared with the capillaries.

162. More about the Capillaries. — The capillaries form a meshwork which serves as a set of connecting links between the arteries and the veins. It is the capillaries that bleed when the skin is pricked with a needle.

We may think of an artery and a vein as like two streets, and the capillaries like millions of little lanes through which the blood finds its way in passing from one street to the other.

In brief, the blood vessels and the heart form a sort of ring, — a circle without a break in it.

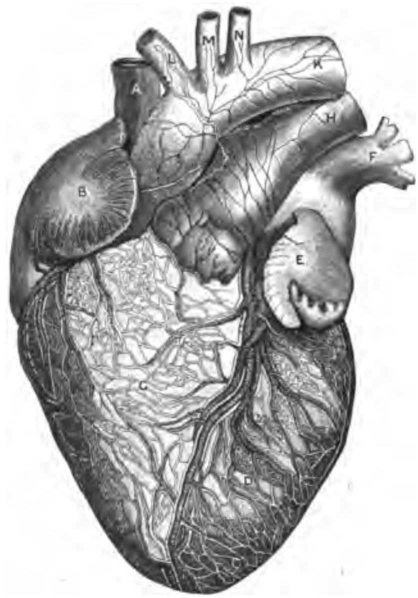

FIG. 76. — Front View of the Heart

A, superior vena cava; *B*, right auricle; *C*, right ventricle; *D*, left ventricle; *E*, left auricle; *F*, pulmonary vein; *H*, pulmonary artery; *K*, aorta; *L*, right subclavian artery; *M*, right common carotid artery; *N*, left common carotid artery

163. The Heart. — The **heart** is the most wonderful little pump in the world; in fact, it is two pumps in one, —

a double pump. There is no machine of its size that is half so clever or so strong at its work, for it never seems to get tired. The heart is similar to a strawberry in shape, and is about the size of its owner's closed fist. It is a muscle; hence it can contract and relax.

FIG. 77. — Schoolboy listening to the Beating of the Heart with a Stethoscope

(From a photograph taken in the class room)

Most of us know that the heart is nearly in the middle of the chest, between the two lungs, with its pointed end turned towards the left side. Here it is constantly beating, like a watch, ticking all day and all night, year after year, never stopping, and never needing to be wound up.

Experiment. — Borrow a stethoscope from some physician. With its aid the location of the heart is easily made out. The end of the stethoscope should be placed about one inch below and to the left of the middle of the left side of the chest (about three inches to the left of the outer edge of the breastbone). Only one thickness of underclothing should be interposed. Listen carefully to the heart sounds of some friend.

164. How the Heart is divided into Rooms. — When the heart is cut open it is seen to be hollow and to be divided into four rooms. First, it is divided down the middle, from top to bottom. There is no door in the partition, so no blood can go directly from one side to the other.

Then each one of these halves is divided crosswise. But these partitions are not quite complete: they have little doors which open and shut and act not unlike the valves of a pump. They open somewhat like a parachute to let the blood through, and close to prevent its return.

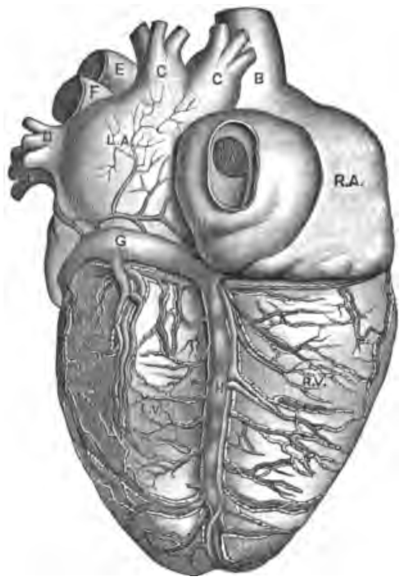

FIG. 78. — Posterior View of the Heart

L.A., left auricle; *R.A.*, right auricle; *L.V.*, left ventricle; *R. V.*, right ventricle; *A*, opening of the inferior vena cava; *B*, superior vena cava; *C*, right pulmonary veins; *D*, left pulmonary veins; *E*, aorta; *F*, left branch of pulmonary artery

Let us now learn the names of these four rooms in the heart, and see what is going on in each.

The two upper rooms are called the **right** and **left auricles**; the two lower rooms, the **right** and **left ventricles.** In each a blood vessel either enters or starts off.

165. The Aorta and its Great Branches. — The largest artery in the body, a large tube called the **aorta**, passes out of the left ventricle. Every time the heart beats, it squeezes about four tablespoonfuls of blood into this great blood vessel. Did you ever notice a blackish thread running along the backbone of a fish before it is cooked? This is the fish's aorta.

This great tube makes a horseshoe bend near the heart, and, clinging close to the backbone, passes down towards the hips, sending out a great number of branches. Arriving at the loins, it divides into two great branches, which send other branches down, some of them to the very tips of the toes.

166. How the Blood gets back to the Heart. — Like a tree, the arteries divide into branches again and again, and these into still smaller branches and twigs, until at last the capillaries are reached.

When the blood has passed through the little capillaries it enters other tiny vessels, which gradually join, making larger and larger vessels, called **veins**, somewhat as brooks unite to form a river. The blood now flows back towards the heart through the veins, and is emptied into the right auricle from the two largest veins of the body.

167. The Circulation of Blood in the Lungs. — How does the blood get from one side of the heart to the other, since there is no opening in the partition between the two sides? It goes around through the lungs.

The blood goes out of the lower room on the right side of the heart through a great tube called the **lung artery.** This artery divides over and over again into

Experiment. — The circulation of blood in a live animal may be shown quite well in the ear of a tame white rabbit. Place the animal on a table about six inches from a lighted lamp. Gently keep one ear on the stretch and so adjusted to the light that the blood in

FIG. 79. — Schoolboy observing the Circulation of Blood in a Rabbit's Ear

(From a photograph taken in the class room)

the central artery can be seen coursing through the translucent membrane. The whole ear has a pink color, and is warm from the abundant blood flowing through it. If the rabbit is kept quiet and not alarmed, by close observation the main artery may be seen to grow smaller and then larger at somewhat irregular periods of a minute or more.

branches, in the substance of the lungs, carrying the blood into the network of the lung capillaries.

We are told that if all these hairlike tubes in the lungs could be fastened together they would reach from

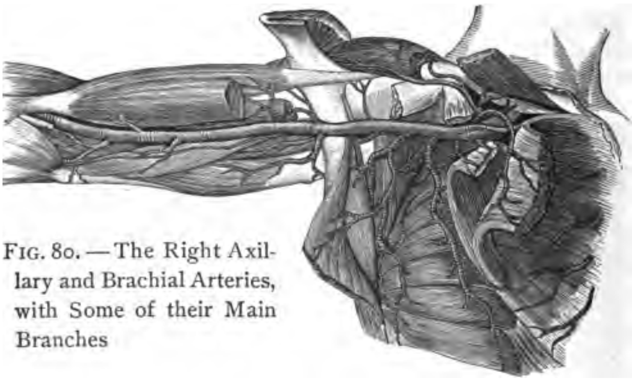

FIG. 80. — The Right Axillary and Brachial Arteries, with Some of their Main Branches

New York City to England and back again. These capillaries in the lungs unite as they do in the rest of the body, and lead into very fine veins, which gradually grow larger and larger.

All the veins at last unite into four great veins, called **lung veins**, which empty the blood into the upper room on the left side of the heart.

From the left side of the heart the blood is pumped all over the body through the arteries.

The blood thus goes round and round in the body, making what is called the **circulation**.

168. What takes place in the Lungs.—When the blood reaches the lungs it needs oxygen. Now the little air

sacs of the lungs, which we shall read about in the next chapter, are full of oxygen, which is carried to them with every breath. From these air sacs the oxygen of the air quickly passes through the thin walls of the capillaries and is then taken up by the red corpuscles of the blood.

But this is not all of the story. The blood that reaches the lungs contains carbon dioxide and other waste matters picked up on its journey through the body. It is in the lungs that this waste is got rid of. It easily passes through the very thin walls of the capillaries into the air sacs of the lungs, from which it is breathed out into the air.

FIG. 81.—The Femoral Artery of Right Leg

The blood thus gets rid of its impurities and is made fresh and clean.

169. How the Heart does its Work. — The heart is really a kind of little force pump, working somewhat as your hand does when you squeeze with it. Every time the heart gives its great squeeze, or "beats" against the chest walls, it pumps a fresh quantity of blood into the arteries. The force given by this beat of the heart helps to keep the blood steadily moving through the arteries, the capillaries, the veins, and back again to the other side of the heart.

The heart can thus pump blood because it is made up chiefly of muscle and can squeeze itself together with a wonderful power. If you think for a moment, you will see that when the walls of a cavity become at one time shorter and thicker they must draw nearer together. The space inside thus becomes very small. This is really what occurs in each of the four rooms of the heart.

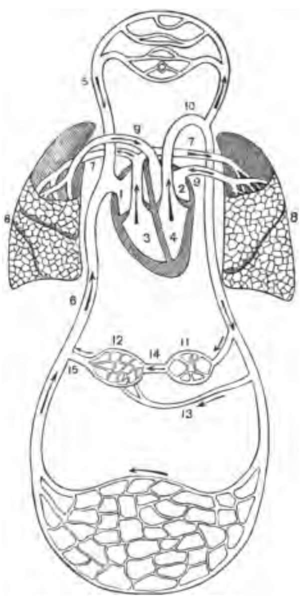

FIG. 82.—Diagram illustrating the Circulation

1, right auricle; 2, left auricle; 3, right ventricle; 4, left ventricle; 5, vena cava superior; 6, vena cava inferior; 7, pulmonary arteries; 8, lungs; 9, pulmonary veins; 10, aorta; 11, alimentary canal; 12, liver; 13, hepatic artery; 14, portal vein; 15, hepatic vein

170. The Journey of the Blood.—Let us follow the blood in its journey around the body. It returns bright and red from the lungs to the left auricle. This chamber contracts and the blood passes through the swinging doors into the left ventricle. This cavity then contracts and pumps the blood into the aorta. From that forcible impulse the blood rushes through the arteries, and thence passes more slowly through capillaries and veins, and is at last emptied into the right auricle.

This chamber in turn contracts and the blood flows down

past the little swinging doors into the right ventricle; this cavity then contracts and drives the blood through the lung artery into the lungs, to be purified and to take up oxygen. Then it is ready once more to go on its journey.

More wonderful still! How long do you think it takes a drop of blood to go its grand round in the body? Only while your watch is ticking twenty-two times. All the blood we have, which is about one tenth of our weight, makes this complete circuit in about two minutes!

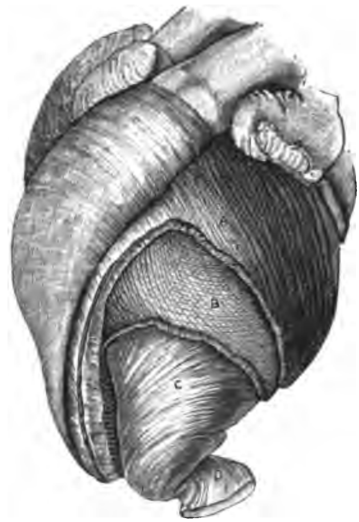

FIG. 83. — Arrangement of Muscular Fibers about the Ventricles of the Heart

A, muscular fibers common to both ventricles; *B*, fibers of the left ventricle; *C*, deep fibers passing upwards towards the base of the heart

171. The Heart as a Wonderful Machine. — What a marvelous machine the heart is! It is busily pumping away, without getting tired, night and day, for threescore years and ten, or even a full century, if you live so long, about seventy-two strokes every minute, over forty-three hundred times every hour, and nearly thirty-eight million beats every year. Let the heart come to a standstill even for one brief moment, and we cease to live.

How quietly this rapid stream of life flows on within us, never stopping for a moment from birth till death! We feel nothing of it but the gentle tapping of the heart and the regular throb of the pulse, as the lifeblood goes swiftly on its ceaseless round.

172. The Pulse. — Press the wrist of a friend, laying two fingers over the outer bone of his arm, or press two of your fingers over the thumb side of your own wrist. You can feel very easily a gentle, regular movement, which is known as the **pulse.** (Fig. 84.)

173. Where the Pulse may be found. — The pulse may be felt everywhere in the body where an artery comes near the surface, as on the temples, the sides of the neck, and near the ankle. Most of the arteries are more deeply buried in the flesh, where it is not easy to feel their throbs.

By feeling the pulse, doctors can tell whether the heart is working at the proper rate or too fast or too slow. They feel your pulse at the wrist simply because it is more convenient for them to do so.

174. Changes in the Rate of the Pulse. — In a healthy adult the pulse beats about seventy-two times a minute.

The pulse is quicker in children than in adults, and slower in old age than in middle life.

In certain diseases, especially in fevers, the pulse goes with great sudden leaps, like a galloping horse; in others it moves in little jerks; while in some very feeble or sick

people it moves slowly and wearily, and its throbs may be so weak that even doctors can scarcely feel them.

Experiments. — With your right hand grasp the wrist of a friend, pressing with two or three fingers over the radius or bone on the thumb side of the arm. By taking pains, the regular, throbbing movement of the artery, or pulse, may be felt.

FIG. 84. — Teacher showing a Schoolboy how to find the Pulse

(From a photograph taken in the class room)

Find your own radial pulse by pressing the left thumb firmly against the lower end of the right radius. With the aid of a watch, count the rate of your own pulse and also that of some friend.

175. Effect of Exercise upon the Circulation. — A proper amount of exercise enables all the organs of the body to do their work with more vigor. When we feel cold a brisk walk or lively game will "start the blood" and make us feel warmer. A daily bath, followed by a brisk rubbing of the skin with a coarse towel, quickens the circulation.

Excessive exercise is, however, to be avoided. Like any machine, the heart may be strained by violent effort. Gymnasts, oarsmen, football players, and others occasionally wrench the delicate machinery of the heart; the result is, oftentimes, many years of ill health.

176. Effect of Pressure upon the Circulation. — Many of the veins lie so near the surface of the body that the flow of blood through them is easily hindered by pressure. Hence no article of clothing should be worn tight enough to interfere with the flow of the blood.

Fig. 85. — The Larger Arteries on the Top of the Right Foot

Tight garters, by checking the circulation, often cause a sense of numbness below the knees, cold feet, and chilblains. Tight collars or bands about the neck may cause dizziness and a feeling of fullness in the head.

Bands, belts, and straps, and even boots and shoes, should never be worn so tight as to hinder the free circulation of blood.

The health of the blood, like that of any other tissue of the body, may be promoted by a nourishing diet, pure air, and a proper amount of rest and clothing.

177. Effect of Alcohol upon the Circulation. — When a person has taken a moderate amount of wine, or other alcoholic drink, it is quite common to see the cheeks flush, the eyes brighten, the speech become more rapid and accompanied, perhaps, with lively gestures.

As alcohol has the power thus to excite the drinker it has been called a *stimulant*, which means something that quickens bodily activity.

Careful study has shown that these livelier actions of the drinker are really due to the slightly benumbing effect which alcohol has upon those parts of the nervous system that control the circulation.

178. Effect of the Habitual Use of Alcoholic Beverages upon the Heart and Blood Vessels. — The habitual use of alcoholic drinks in amounts which by many would be considered moderate often causes changes in the structure of the heart and in the large arteries, weakening them so much that they cannot do their work well.

FIG. 86. — The Ulnar and Radial Arteries of the Left Arm and Hand

179. Effect of Tobacco on the Heart. — Tobacco has a powerful effect upon the action of the heart. A weak and intermittent pulse, due to the irregular action of the heart, is a common result of its use. This trouble disappears after the tobacco is abandoned. Applicants for life insurance are frequently rejected because of a "tobacco heart."

QUESTIONS FOR REVIEW

1. How does blood look to the naked eye?
2. What gives the red color to blood?
3. Describe the red blood corpuscles.
4. Give some familiar illustration to show their small size.
5. Of what use are the red corpuscles?
6. To what may we compare the red corpuscles?
7. Describe the white blood corpuscles.
8. What is supposed to be the duty of the white blood corpuscles?
9. How will you explain the clotting of blood?
10. What is meant by the circulation of the blood?
11. What can you tell of Harvey and his discovery of the circulation of the blood?
12. What are arteries and veins?
13. Tell what you can about the capillaries.
14. Describe the heart, and show how it is divided into rooms.
15. What is the aorta?
16. Describe some of the main branches of the aorta.
17. How does the blood get back to the heart?
18. Describe the circulation of blood in the lungs.
19. How does the heart do its work?
20. Describe the journey of the blood.
21. What can you say of the heart as a wonderful machine?
22. What is meant by the pulse, and where may it be found?
23. Describe the effect of exercise upon the circulation.
24. How is the circulation of the blood affected by tight bands or clothing?
25. What is the effect of alcohol upon the circulation?
26. What is the effect of the habitual use of alcoholic beverages upon the heart and blood vessels?
27. What is the effect of tobacco upon the heart?

CHAPTER IX

WHY AND HOW WE BREATHE

180. All Animals breathe. — When we watch a cat or a dog, we see their sides move in and out with the motions of breathing. We notice the breath puffing out of a horse's nostrils as he rests after a hard pull.

On cold winter mornings we may see our breath like a cloud of steam. The air which we breathe may feel cold as it passes in through the lips. It is warm as it goes out, as you know, for we can warm our cold finger tips with the breath.

181. Breathing. — Breathing is drawing air into the lungs, and sending it out again. The whole process of breathing is called **respiration**, and consists of two movements, namely:

The act of drawing in the breath, known as **inspiration.**

The act of sending it out, called **expiration.**

Plants breathe, but we cannot see them do it, for they have no lungs to expand. They breathe in a very different way, through tiny holes in their leaves.

Animals breathe by means of a wonderful and beautiful set of machinery, which we are now ready to study.

182. The Location of the Lungs. — Strike the upper part of your right chest, just below the collar bone, with the flat of your hand. Now strike the knee in the same way. Notice what very different sounds you hear.

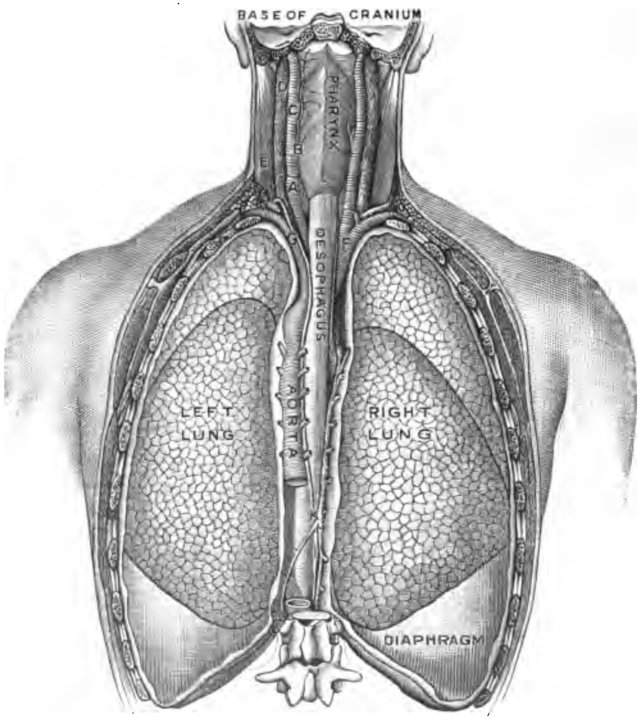

FIG. 87. — The Position of the Lungs, the Heart, and Some of the Great Vessels belonging to the Latter. (Posterior View)

A, *B*, and *C*, large arteries (carotid) on left side of neck; *D*, large vein (jugular) on left side of neck; *E*, muscle running from the collar bone to the head; *F*, large artery on right with branches to the head and the arm; *G*, large artery on left (subclavian) running under the collar bone; *H*, large vein; *K*, thoracic duct

The **lungs**, which you may think of as two large elastic bags, are placed one on each side of the chest, within the bony cage made by the breastbone, ribs, and backbone.

The chest sounds hollow because the lungs within it are filled with air.

Experiment. — The sound made by the air as we breathe in and out of the lungs may be heard fairly well if we apply the ear flat to a friend's chest, with only one garment interposed. A much better idea of the respiratory sounds may be obtained by the use of a physician's stethoscope. The teacher may show pupils how to place the instrument in a correct position over the front or back of the right side of the chest. The sounds of the heart should not be confused with those of breathing.

FIG. 88. — Schoolboy listening to the Sounds of Respiration in the Lungs of a Schoolmate with the Aid of a Stethoscope

(From a photograph taken in the schoolroom)

183. How the Lungs look. — How do the lungs look? They are two large pinkish organs, which occupy almost all of the chest cavity. They are made up of spongy tissue, the cavities in which, called **air sacs**, are filled with air.

The next time you go to the market, ask the marketman to show you the lungs, or "lights," as he calls them, of a calf or a sheep. Cut off a small piece, and examine it at home carefully. Take a piece in your hand and you will find it quite light and soft. It sinks under your finger if you press it, and rises again like a sponge. You will also notice a crackling sound, caused by air being forced out of the air sacs. If it is thrown into water, it will float.

184. The Air Passages.—We breathe air into the lungs through the mouth, the nostrils, and the windpipe.

The nose warms and filters the air somewhat before it starts on its journey to the lungs; hence we see how important it is to breathe through the nose at all times.

If you lean your head back, you can easily feel in the middle of the neck, in front, a stiff tube. This is the **windpipe**, which opens into the back of the mouth and serves as a passageway for the incoming and outgoing air.

185. The Epiglottis. — There is a small lid of gristle, like the tongue of a little bird, in front of the open top of the windpipe, which, as you have been told before, is called the **epiglottis**. It shuts down when food is passing by; hence it does not in health prevent the air from entering the windpipe. (Sec. 124.)

186. The Vocal Cords. — The upper part of the windpipe is not unlike a kind of box and contains the organs of voice. In this box are the **vocal cords**. The front of this

box, easily seen in thin men, is commonly called "Adam's Apple." The vocal cords are not strings, but elastic strips, with free edges, which can be made tight or loose.

As the air passes to and from the lungs through the narrow chink between these cords, it sets them to vibrating, and thus the sound called the **voice** is produced. During ordinary breathing the vocal cords are widely separated.

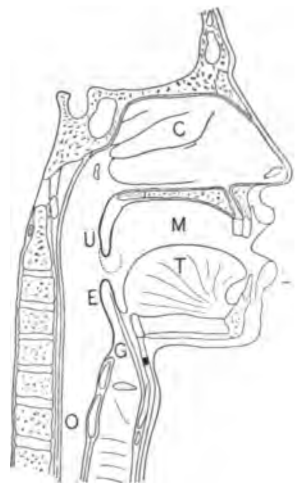

FIG. 89. — BLACKBOARD SKETCH

Diagram of a Sectional View of Nasal and Throat Passages

C, nasal cavities; *T*, tongue; *L*, lower jaw; *M*, mouth; *U*, uvula; *E*, epiglottis; *G*, larynx; *O*, gullet, or œsophagus

187. The Bronchial Tubes. — The windpipe passes down into the chest, and divides into two branches called **bronchi**, one going to each lung. These divide into other branches, called **bronchial tubes**, and these into more branches, and so on. Thus each bronchial tube keeps on dividing into smaller and smaller branches, the tubes becoming finer with every division, until they are smaller than the tiniest hair.

188. The Air Sacs. — Each one of the little bronchial tubes has on its end a little bag, called an **air sac**, somewhat like a red currant on its stalk, only much smaller than a grain of sand.

Imagine a short, thick tree crowded with leaves; imagine the trunk and all the branches, even the smallest twigs, to be hollow. Suppose the leaves were tiny elastic bags, blown up, and fastened to the smallest hollow twigs. Roughly speaking, this is somewhat like the structure of the innermost parts of the lungs.

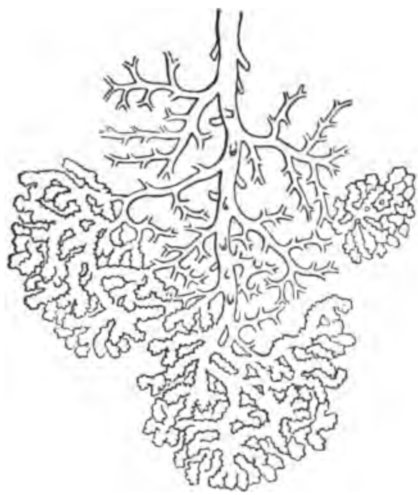

FIG. 90. — BLACKBOARD SKETCH

Diagram of a Small Bronchial Tube and its Divisions into very Small Branches, also showing Groups of Air Sacs at the Termination of Minute Bronchial Tubes

189. How the Air Tubes are provided with Blood Vessels. — Around this framework of hollow branches, called bronchial tubes, and elastic bags, called air sacs, is wrapped a finely woven network of arteries, veins, and capillaries. You will get a better idea of this if you think of a child's ball which you may have seen covered with a fine network of red and blue yarn.

The air fills the cavities in the lungs when the chest becomes larger, just as it fills a pair of bellows when the handles are separated. When the chest becomes

smaller the air is driven out, as it is from the bellows when the handles are brought nearer to each other.

190. How we breathe. — How do we draw our breath? Let us try to learn something about it. The air tubes and air sacs make up about one half of the substance of the lungs, and nearly the other half consists of blood vessels. Both the blood vessels and the air sacs are supported by a framework of elastic tissue.

FIG. 91. — Schoolgirl finding the Expansive Power of the Chest by means of a Tape Measure

(From a photograph taken in the schoolroom)

Experiment. — To measure the chest and also to show how the chest varies in size during respiration. Stand before a mirror with the shoulders well thrown back. While breathing naturally pass a tape around the body just under the arms, bringing the ends of the tape together across the front of the chest. Take the exact measure. Take a long, deep breath, letting the tape slip through the fingers until the chest is fully expanded. Note the measurement. Now let out the breath slowly and fully, and measure as before. Note the difference in inches between the act of inspiration and that of expiration. This difference, usually about three inches, is the expansive power of the chest.

We know that we can stretch a piece of elastic to a certain length, and then it springs back to its first size. In somewhat the same way the elastic tissue of the lungs acts. It is stretched as the air is drawn into the air tubes. It returns to its first size as soon as we stop drawing in the breath, and so presses on the larger air tubes and forces the air out of them.

191. The Work done by the Diaphragm and other Muscles. — The lungs are attached on the under side to a great muscle called the **diaphragm.** This, as you already know, stretches like a stout piece of rubber cloth between the chest and the abdomen. In its natural position it bulges upwards in the middle, like a handkerchief swollen by the wind, and thus occupies a portion of the chest at the expense of the lungs. (Fig. 87.)

When we are about to breathe in air, the muscular fibers of the diaphragm tighten, and it becomes flat, just as you make the handkerchief flat by tightening it. The chest is thus enlarged. This gives the lungs room to expand, and they do so at once. As soon as this happens, air rushes in from the outside through the air passages into the little air sacs. This act of breathing in air is known as **inspiration.**

Now when the diaphragm relaxes, the lungs contract, causing their elastic tissue to shrink again; and so the air is forced out of the air sacs. This act of breathing out air is called **expiration.**

These up-and-down movements of the diaphragm are the chief motions in ordinary quiet breathing. This process is repeated over and over again as long as we live.

This faithful servant, the diaphragm, quietly began its duties the moment we breathed for the first time. Since that time it has been on constant duty, taking part in every breath, and its last effort will be our last sigh.

The muscles between the ribs, and other muscles of the chest also, contract and relax, first making the chest cavity larger, and then smaller, and are thus useful in the act of breathing.

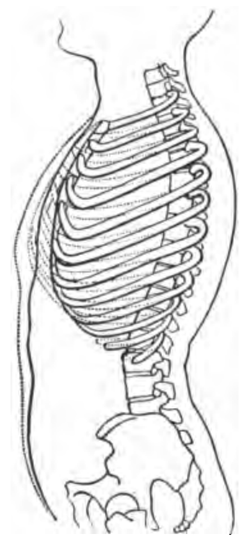

FIG. 92.— BLACKBOARD SKETCH

Showing the Expansion of the Chest and the Movements of the Ribs during Respiration

The dotted lines indicate the position of the chest and ribs during a full inspiration

192. The Two Gases in Pure Air. — There are two kinds of gases in pure air. The first is very lively and active, called **oxygen.** It is very fond of uniting with other things and burning them. Thus, substances like wire, which will not burn in ordinary air, will burn as readily as paper in oxygen.

The second is a very slow, dull substance, called **nitrogen,** and nothing will burn in it.

Oxygen, if quite pure, would be altogether too active a gas for us to live in; so kind Nature dilutes it with nitrogen. In the air we breathe these two gases are mixed in about the proportion of one fifth of oxygen to four fifths of nitrogen.

193. What takes Place in the Lungs. — When the air reaches the tiniest capillaries in the air sacs of the lungs, the oxygen it contains is almost in contact with the blood itself. There is only a very thin membrane between the blood and the air.

Now, experiments prove that gases can pass through delicate membranes. If a bladder filled with oxygen is hung up in a bottle filled with carbon dioxide, the two gases will mix with each other. The oxygen will pass out through the walls of the bladder, and the carbon dioxide will pass in. This is in accordance with the law of science known as the *diffusion of gases.*

This is practically what takes place in the lungs. Thus there is an exchange, but no robbery. The blood exchanges a useless gas for one which gives it new life.

We may, in brief, look upon the lungs as a kind of market place, or exchange, where two merchants, the blood and the air, meet to exchange their wares. About thirty cubic inches of air pass in and out of the lungs with every breath, or about what would fill sixty barrels every twenty-four hours. Indeed, we may well think of the lungs as a very busy market place.

194. Changes in the Air from Breathing. — When we breathe, we do not simply draw in the air and send it out again; but we breathe out some things which were not in the air when we took it in.

With every breath we breathe out a small amount of animal matter from our bodies. This gives the air of an ill-ventilated or over-crowded room the close, disagreeable odor we all know so well. Pure air has no smell.

Experiment. — A simple experiment may show that the air we breathe out contains the gas known as carbon dioxide. Put a glass tube (a long straw or a sheet of stiff paper rolled into a tube may be used) into a tumbler half full of clear limewater. If we breathe out or exhale through the tube, the liquid will soon become milky. The carbon dioxide in the air breathed out unites with the lime held in solution and forms what is known as carbonate of lime.

FIG. 93. — Schoolboy testing for Carbon Dioxide by breathing into Limewater

(From a photograph taken in the schoolroom)

On a cold, frosty morning we see the clouds of vapor, or very fine drops of water, coming from our mouths. In hot weather or in a warm room we do not see this vapor, but it is there. If we breathe on the bright blade of a jackknife,

it becomes dim and damp with the moisture of the breath. There is, of course, a little watery vapor in the air, but hardly any compared to what there is in the breath.

195. How Carbon Dioxide may poison us. — As we have just learned, we send out with every breath a kind of gas, called **carbon dioxide**, which we cannot see any more than we can see the air.

The animal matter which is always mixed with the carbon dioxide which we breathe out acts as a deadly poison. If there is too much of it in the air we breathe, it poisons us. We soon breathe hard, grow pale, faint, and dizzy, and after a time we should die.

Perhaps you have read the dreadful story of the "Black Hole of Calcutta." Many years ago a cruel tyrant in India, having captured a hundred and forty-six English prisoners, crowded them one hot night into a room less than twenty feet square. Two little windows did not admit enough air for the poor captives to breathe. They struggled and fought for the air, and in the morning only twenty-three were alive.

After one of Napoleon's great battles three hundred prisoners were crowded into a cave for safe-keeping, where in a few hours over two hundred died from the foul air.

196. Pure Air, and how it is kept so. — One would think that all the pure air in the world would long ago have been breathed over and over again and have become bad.

Think for a moment what a great number of people have lived in the world. How many men, women, and children there are now, especially in great cities like New York and Chicago, all breathing out carbon dioxide and other impurities from their lungs. It seems strange that there is any air left fit for us to breathe.

Why does not the supply of oxygen ever fall short? What becomes of the carbon dioxide? First, let us see what the latter is made of, — two very good things, oxygen and carbon.

A great deal of our flesh and blood is made of these two things; but when they are united, to make this gas, they are of no use to us. We might go to the store and buy salt and sugar; but if they got mixed together as we brought them home, we could not use either, unless some good fairy could pick them apart for us.

197. How Nature provides us with Pure Air. — Now, can anybody separate the carbon and oxygen in the carbon dioxide, and thus make them fit for us to use again? Yes, indeed. There are millions of workmen about us that are busily doing this very thing all the time.

Every plant, every green leaf, every blade of grass, is doing this for us. When the sun shines on them, they pick the carbon out, and send back the oxygen for us to breathe. They keep the carbon, and give it back to us in our plant and animal food. Is not this a wonderful arrangement?

Experiments. — Important changes in the air during respiration may be shown with simple apparatus. Expired air is warmer than the ordinary air of a room. Note the temperature of a room as shown by the thermometer. Breathe for a few moments on the bulb of a thermometer. The mercury rises.

There is more moisture in the air expired. Note that the polished bulb of a thermometer is free from moisture; breathe upon it and it becomes covered with a film of moisture.

FIG. 94. — Schoolgirl performing Experiments to show Changes in the Air during Respiration

(From a photograph taken in the schoolroom)

Another change is in the amount of carbon dioxide in the expired air. Use a bottle with a rubber stopper fitted with two glass tubes, each bent at a right angle. One tube is short and projects only two inches or so into the bottle. The other tube reaches nearly to the bottom of the bottle. Fill the bottle half full of limewater. Put the mouth to the shorter tube, drawing air into the lungs which comes through the limewater. There is no change in the limewater, as the outside air has little or no carbon dioxide. Now put the mouth to the longer tube and breathe out the air in the lungs through the limewater. The limewater becomes milky, as shown in the experiment, page 141.

How does all the bad air get out of the towns and cities where men live? How is it carried over the mountains and across the lakes and plains? The wind carries it. Air is constantly moving about, rising up,

falling down, sweeping this way or that way, and blowing from place to place. In brief, as the Bible tells us, "The wind bloweth where it listeth" (pleases).

198. How People poison themselves with Impure Air. — Not only the little particles out of our breath may make the air unwholesome, but also many other things. Even pleasant odors, like those of roses or lilies, are unwholesome if shut up in a room.

Dirty walls, ceilings, and floors give the air a bad smell; so do dirty clothes, filthy sinks, damp cellars, and the contents of slop pails.

While all we have told you about pure air applies to persons in health, it applies still more to sick people. First, because sick people need every possible aid to get well. They need good air just as much as they need good food. Second, because everything that comes from a sick person's body is more unwholesome than what comes from a healthy person, and may be a downright poison.

199. How the Germs of Disease may be carried about in the Air. — Many learned men now believe that numerous diseases are really sown in our bodies by a kind of very small seed, or "germ." For instance, scarlet fever, it is believed, has its own seeds, or germs, which are shed in countless numbers from the body of a person who is suffering from it. Some of these float in the air; and if we breathe them in, they are quite likely to give us the fever if we have not already had it. The same may be true

of measles, smallpox, whooping cough, and other contagious diseases.

200. Other Ways in which the Air may become Unwholesome. — Many other things make the air unwholesome. The foul air from chemical works, bone and soap factories, garbage heaps, sewer and drain pipes, and many other places is more or less hurtful to health.

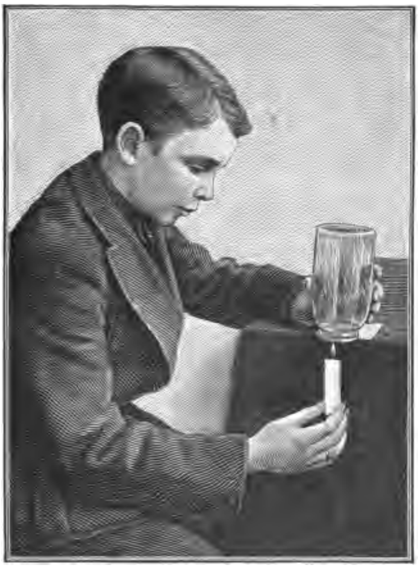

FIG. 95. — Schoolboy performing Experiments to show that the Air we breathe out is impure

(From a photograph taken in the schoolroom)

Experiment. — Place a short lighted candle on a table and cover it with a quart fruit jar. The flame will soon go out because the burning candle has burnt up the oxygen, which has been replaced by carbon dioxide. Even if we draw the jar carefully to the edge of the table and allow the candle to drop out, the air in the jar will remain impure. This is shown by putting up the burning candle again, as in Fig. 95, and noting that the flame will go out at once. If we change the air by waving the jar to and fro several times, the candle will burn with a bright flame for a few moments.

Certain trades shorten life by the exposure of the worker to air loaded with impurities. Thus there is the

"miner's consumption," due to the dust breathed into the lungs. Those who work on steel, emery, pottery, etc., also breathe in the irritating dust floating in the air. The dust in match factories, white-lead works, copper and brass foundries, and from arsenic in wall papers are highly injurious to the lungs.

FIG. 96. — Schoolboy performing Experiments to show Changes in the Air that we breathe out

(From a photograph taken in the schoolroom)

Experiment. — A simple experiment with a fruit jar proves that the air we breathe out is impure. Place a piece of cardboard over the mouth of a fruit jar (Fig. 96). Pass a glass tube into the jar through a hole in the board. Through the tube breathe in and out from the jar several times. Carefully invert the jar and test with the candle as in Fig. 95. The flame will go out at once, as the candle will not burn in the carbon dioxide which is exhaled and which has replaced the oxygen of the pure air. In brief, we breathe out air that is as impure as that which put out the candle in the preceding experiment.

201. Ventilation, or how to get rid of Impure Air. — How are we to get rid of the bad air in our living rooms, and get in fresh air without being too cold? In summer this

is quite easy; but in winter it is more difficult, because it is very uncomfortable and often dangerous to be cold.

It is a good plan to open our windows at the top, thus letting out the bad air. If we have a good fire and proper clothing, it is very seldom that we cannot bear the window open a little way at the top.

Another excellent plan is to raise the lower sash, putting below it a strip of board two or three inches wide and as long as the width of the window, and shut the sash on it. This leaves an opening for fresh air at the middle of the window.

202. The Ventilation of Bedrooms. — Good ventilation is just as necessary by night as by day, because, of course, we go on breathing all night. People who take pains to shut in the bad air, and to shut out the good air, all night long, cannot expect to awake refreshed.

It is very unpleasant to go into such bedrooms before they have been aired in the morning. It is not strange that persons sleeping in such rooms are often languid, pale, or peevish during the first part of the day.

People are sometimes afraid of letting in night air because they think it is unwholesome. This is not true. Those who have tried it know very well that they sleep better, and awake fresher, if they keep the air of their bedrooms clean and sweet all night. As the famous nurse, Florence Nightingale, aptly said, "What air other than night air can we breathe at night?"

There is hardly a night in the whole year when it is not safe to keep a bedroom window open at least an inch or two at the top. We must have, however, proper coverings on our beds to keep us warm.

203. The Effects of Alcohol and Tobacco upon the Air Passages. — Catarrh of the air passages is especially common with those who have injured themselves by alcoholic drinks. Those who have studied the causes of consumption tell us that these drinks may prepare the way for this dread disease. Besides making the drinker careless about exposing himself to cold and wet, the use of alcoholic liquors renders him less able to resist an attack of pneumonia, or the germs that cause consumption.

Breathing air full of tobacco smoke is apt to cause sore throat. The habit of inhaling tobacco smoke, or breathing it through the nose, is injurious to the throat and the lungs. Cigarette smoke, especially, may irritate and inflame the air passages.

QUESTIONS FOR REVIEW

1. What familiar examples can you give showing that all animals breathe?
2. What is meant by breathing, or respiration?
3. What are the lungs, and where are they located?
4. Describe the appearance of the lungs.
5. Describe the nostrils and the windpipe.
6. What part does the epiglottis play?
7. Show how the voice is produced.
8. What are bronchial tubes?
9. Describe air sacs.
10. How are the air tubes provided with blood vessels?
11. Tell something about the work done by the diaphragm.
12. Describe in full the process of breathing.
13. What two gases are in pure air?
14. What takes place in the lungs during breathing?
15. What important changes take place in the air from breathing?
16. Tell what you can about the poisonous effects of carbon dioxide.
17. How is the air kept pure?
18. How are people poisoned by breathing impure air?
19. How does Nature provide us with pure air?
20. Show how the germs of disease may be carried about in the air.
21. In what other ways may the air become unwholesome? Give illustrations from trades which tend to shorten life.
22. How may we get rid of impure air in our living rooms by some simple means of ventilation?
23. Give some practical plans of ventilation.
24. What can you tell about the ventilation of bedrooms?
25. What are the effects of alcohol and tobacco upon the air passages?

CHAPTER X

HOW OUR BODIES ARE COVERED

204. Getting rid of Waste Matters. — When a fire in a stove or furnace burns, it uses up coal and wood, leaving dust and ashes behind. These must be got rid of before fresh fuel will burn readily. Our bodies are doing something very similar. They are all the time using up food, and are all the time making waste matter which must be got rid of.

205. The Outlets for Waste Matter. — There are several outlets by which the body rids itself of its waste products.

One of these is the **intestines**, which, as we have learned, help rid the body of certain waste matters from the food which we eat.

A second is the **lungs**, which carry off, as we have seen, carbon dioxide, water, and animal matter.

A third outlet is the **kidneys**, which filter off water holding a number of salts and other substances dissolved in it. The action of the kidneys is explained in the more advanced books on this subject.

Let us now see how a fourth outlet of the body, or the **skin**, helps to purify the body of waste matters.

206. The Skin. — Our body is covered with a soft, elastic, tight-fitting garment, — the **skin**. It fits even more neatly than a kid glove, and yet is so elastic that it yields to every movement of the parts which it covers. The skin protects the soft parts beneath and prevents too great a loss of the bodily heat.

207. The True Skin. — It is quite easy to run a fine needle through the outer skin without feeling it or drawing blood; but push the needle in a little deeper and it hurts, and the blood will run. Why is this? Simply because there is a lower, thicker layer called the **true skin**, which is full of the finest blood vessels and nerves.

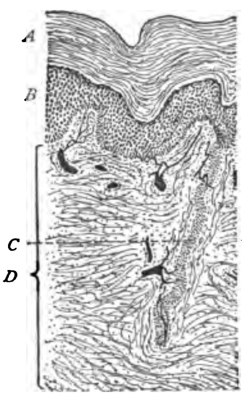

FIG. 97. — Cross Section of Skin. (Magnified 30 diameters)

A, outer layer of scarfskin; *B*, deeper layer of scarfskin; *C*, duct of sweat gland; *D*, true skin

We all know how very tender is the delicate pink skin seen when the outer layer of a blister is torn away. This is the true skin. A deep cut through this results in a scar. See if you can find such a scar on your hand.

208. The Outer or Scarfskin. — Over the true skin lies a layer of flat, lifeless scales, in which are no blood vessels and no nerves. This is called the **scarfskin**, or **epidermis**. We often give ourselves a little scratch without making the blood run, or feeling any pain. It is

the scarfskin which is raised into a blister when we burn our fingers. The scarfskin really consists of a countless number of little scales, laid one above another, somewhat as several layers of shingles might be laid on the roof of a house. The outer scales are all the time wearing off and new ones are always forming underneath.

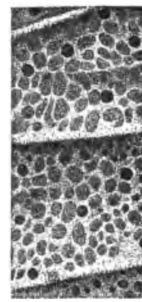

FIG. 98.—Outer Skin as shown on the Bottom of the Foot

209. How we get rid of the Scarfskin.—A snake, as you may know, sheds its whole skin at once,—as if a boy should crawl out of his clothes; and sometimes you may find in the fields its cast-off skin turned inside out, just as the snake squirmed out of it and crawled off wearing a soft new dress. Perhaps you have watched a toad in your garden pull off his coarse, warty skin. We shed our skin a little at a time, and in such tiny, powdery scales that we cannot usually see them.

If we take a garment that has been worn next to the skin and shake it in the sunlight, we see how much dust there is inside of it. Much of this dust is really bits of the scarfskin which have dropped off or worn away. Where the skin is pretty thick, as on the palms of the hands or the soles of the feet, we can, when we bathe, see the dead skin peeling off in little scales.

210. What gives the Skin its Color.—Did you ever think why the skin of some people is quite fair and of

others is very dark? What variety of tints we can see in the faces of the people we meet every day! The deeper layer of the outer skin contains a large number of paint or pigment cells, in which coloring matter is stored. This is the reason why some races have white or black, and others red or yellow skins.

Sometimes the sun or a cold wind may act upon these paint cells and make dark colored spots upon the skin. When Nature thus spatters her drops of paint upon the skin in various parts of the body, we call them freckles, liver spots, and by other names.

211. The Sweat Glands. — If we look at the skin on the tips of the fingers through a magnifying glass we see a great number of little holes called *pores*. Just think how small they are! More than three thousand have been counted to the square inch on the skin of the palm, and we are told that there are more than two and one half millions of them in the covering of the whole body.

Each pore is the end or opening of a tube called a **sweat gland**. Each gland is a tiny tube just under the scarfskin, rolled round and round like a loosely wound ball of the finest silk. Perhaps you have seen candy rolled and twisted in and out upon itself in this same way. If all the sweat glands in our body could be unrolled, and laid end to end like a long gas pipe, they would extend more than two miles.

212. The Work done by the Sweat Glands. — What work do these sweat glands do? A very important work, indeed. Let me tell you about it. Certain waste matter picked up by the blood is strained out through the thin walls of the blood vessels into the sweat glands, up which it rises until it oozes out of the openings, when it is called **sweat**, or **perspiration.**

FIG. 99. — Schoolboy examining the Skin in the Palm with the Aid of a Magnifying Glass

(From a photograph taken in the schoolroom)

Experiments. — The living skin can be examined only in a general way. Stretch and pull it, and notice that it is elastic. Examine the outer skin carefully with a strong magnifying glass. Study the little hillocks, or papillæ.

Study the openings of the sweat glands with the aid of a strong magnifying glass. They are conveniently examined on the palms.

Dip the end of a wooden toothpick into some thick ink and spread it very thin over the end of the forefinger, or press the end of the finger on a color pad. Now press the finger tip on a piece of heavy, uncoated paper. Study the impression made by the ridges on the finger.

If we hold the tip of a finger very close to a mirror, but without touching the glass, we soon see a moist spot on the glass. This is because the sweat has oozed out of the pores of our finger and collected on the mirror. If the

mirror were held to any other part of the skin, it would also become dim and moist. (Experiment, page 168.)

213. How the Weather may affect the Work of the Sweat Glands.—The sweat glands thus serve as little drainpipes to rid our bodies of waste matters. When the weather is very hot, or when we are working hard, or are exposed to much heat, the sweat flows so freely that it may stand on the skin in big drops; but at other times it flows more slowly. Still, it is always oozing out, even in the coldest winter weather. About two pints of sweat flow every day through these busy little glands in the skin.

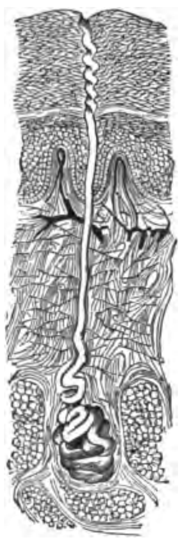

FIG. 100.—Vertical Section of the Skin, showing a Sweat Gland with its Duct

The sweat gland may be traced through the true skin to its outlet in the horny layers of the outer skin

214. The Oil Glands.—The skin is naturally soft, and the hair, growing from it, is soft and glossy. What makes them so? Two little **oil glands**, attached to each hair, furnish this natural dressing for the hair and the skin. We may call it Nature's hair oil.

215. Why we need to keep clean.—A great deal of the sweat soaks into our clothing, which therefore needs frequent washing; but most of the moisture dries off into the air, and thus helps to cool the body. Some of the oily **matter,**

however, sticks to the skin, and together with the dirt or dust from the outside makes a little plug, as it were, over the pores. If the pores are thus stopped up, the waste matter cannot filter through the skin. It has to stay in the body, or find its way out elsewhere.

216. Effect of stopping up the Drainpipes of the Body. — Suppose the drainpipes which lead from a house should get stopped up; we can imagine what an unwholesome state the house would soon be in. Just so it is with the body if the little pipes which drain the skin get clogged. If all the pores of our skin were stopped up we should die within a few hours.

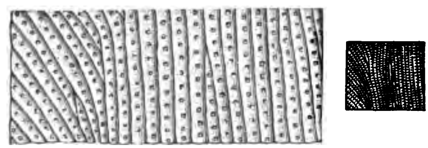

FIG. 101. — Surface of Palm of the Hand, showing Openings of Sweat Glands and Grooves between Papillæ of the Skin. (Magnified 4 diameters)

In the smaller figure the same surface of the skin is shown as seen with the naked eye

217. How the Skin can absorb Poisons as well as Helpful Things. — The pores of the skin can take in or absorb very small quantities of a few things. Doctors sometimes rub various oils into the skin of feeble or thin persons to make them stronger or fatter. Ointments with medicines in them are also rubbed into the skin.

The ancient Greeks used to rub oil into the skin after a hot bath. It was once the fashion for fine ladies to bathe in hot milk to improve their health. Shipwrecked sailors and others who are unable to get fresh

water often soak their clothing in salt water to ease their intense thirst.

The skin may absorb harmful substances through a tear from a hangnail or even through a simple scratch. House painters are often poisoned by the lead which they handle in their paint. Poisons are frequently absorbed by the skin from plants, such as dogwood and poison ivy.

218. The Discovery of Vaccination. — The fact that the skin easily absorbs certain infectious matters is made use of in the process of vaccination. Many years ago smallpox was very common and very fatal. Even the cows suffered from cowpox, a form of the same disease. English people noticed that the young women who milked the infected cows did not often have the real smallpox but only a lighter and less fatal form of the disease. A young medical student in England, named Edward Jenner, studied long and hard to explain this remarkable fact. His experiments resulted after many years in the discovery of **vaccination**, a discovery which has saved thousands from death by this dread disease. The crowning experiment, or the first vaccination, was performed on a small boy whom Jenner inoculated with matter taken from the hand of a milkmaid who had been directly infected by the cow. This was in the year 1796, — three years before Washington died.

219. We need Clean Skin and Clean Clothes. — How necessary it is to have a clean skin and to wear clean

clothes! Many people think they have done quite enough if they wash their hands and faces every day.

We must not forget that it is just as necessary to wash the parts of the body that are not exposed to the air

FIG. 102. — The First Vaccination, — the Crowning Experiment of Dr. Edward Jenner

(Based upon a photograph of a famous French painting)

and are covered with clothing. The reason is very plain, for you must remember that the waste matter that collects on these parts from the inside of the body is just as unwholesome as the outside dirt that gathers on the hands and face.

220. Hints on taking a Bath. — A cold bath just after getting out of bed in the morning is one of the best of tonics. It rouses the nervous system and gives vigor to the circulation. A warm bath at bedtime is refreshing, and favors sound sleep. There is little risk of taking cold if we go to bed at once.

Most persons, especially the young and vigorous, soon get used to cool, and even cold baths. The first effect of any cold bath is to shrivel up the skin and make it look like "goose flesh." Brisk rubbing with a coarse towel will soon bring on a reaction as it is called, after which a genial glow is felt all over the person.

221. Hints on Swimming. — Swimming in fresh water or in salt water has a wholesome effect on the skin, and is one of the most healthful of exercises.

So highly did the Romans regard swimming, that, to express their contempt for an ignorant person, they would say, "He can neither read nor swim." All young people should be taught to swim.

Never go into the water soon after eating, or when overheated or very tired. Sit down quietly and rest or cool off first. Many persons are drowned every year from ignorance or carelessness in these matters. The risk is from sudden cramps, which cause even a strong swimmer to sink like a lump of lead. Alexander the Great once nearly lost his life by swimming in a very cold river just after a full meal.

222. The Hair. — The **hair** and the **nails** really belong to the skin.

The hair grows out from little sacs or bags in the skin, and so do the nails. Every hair has a little bulb or root, which is fixed in the skin, and soaks up the nourishment from the blood vessels. Each little hair has fibers of muscles attached to it which may make the hair stand up. We have all seen the hair of a cat or a dog begin to bristle when it was angry.

FIG. 103. — Hair and Hair Follicle

A, root of hair; *B*, bulb of hair; *C*, *D*, sheaths or coverings of root of hair; *E*, outer covering of follicle; *F*, muscular fibers attached to follicle; *H*, oil gland with its duct, *K*; *L*, simple oil gland; *M*, opening of hair follicle

223. Why the Hair should be kept Clean. — The hair should be washed, combed, and brushed. The reason is plain. The oil glands get clogged; and the dust and the dirt, making rapidly on the scalp a coating, commonly called *dandruff*, get caught in the hair; hence it adds to comfort and health to keep the hair clean.

224. The Color of the Hair. — The color of the hair, as well as that of the skin, is given to it by pigment. Little cells filled with this coloring matter are attached to the root of the hair. In some people, especially old persons, the hair for some reason loses its color, or, as we say, turns gray.

Sudden fright or great sorrow will sometimes turn the hair white in the course of a few hours. It is said that at the time of the cruel Revolution in France the hair of the poor French queen, Marie Antoinette, turned white in a single night, owing to the distress and agony of mind she suffered for the safety of her husband and children.

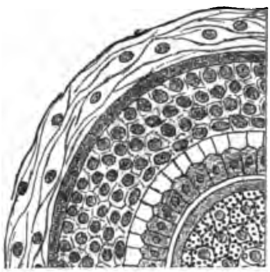

FIG. 104. — Cross Section of One Fourth of a Human Hair. (Magnified about 300 diameters)

225. The Nails. — The **nails** of the fingers and toes grow out from the skin like broad, flat hairs, and are really only a kind of scarfskin.

Some people, especially school children, spoil the looks of their fingers by biting their nails. Instead of pretty oval, bright pink, shell-like ornaments, as they should be, we see only ugly, stumpy fingers, with sore tips to them, which can feel nothing delicately or tenderly.

226. Care of the Nails. — The finger nails should be trimmed with scissors once a week, leaving them long enough to protect the ends of the fingers. The nails should never be trimmed to the quick. They should not be cleaned with anything harder than a bit of soft wood or an orange stick. They should not be scraped with a penknife or scissors, as this will hurt their nice polish.

To prevent hangnails, the skin should be often loosened from the nail, not with a knife or scissors, but with something blunt, such as the handle of a nail brush, an ivory paper cutter, or better still, the end of an orange stick.

227. Effect of Tobacco on the Skin. — Tobacco gives the skin a peculiar dry and sallow look. If a confirmed tobacco user be put in a warm bath the odor of the tobacco may be easily perceived in the room when he comes out.

FIG. 105. — Nail in Position

A, fold of skin turned back to show root of nail; *B*, fold of skin covering root of nail; *C*, half-moon-shaped whitish portion; *D*, body of nail

This is because the pores of his skin become saturated with tobacco. But we need not put the tobacco user into a bath to discover this. The odor of tobacco is constantly passing out of his skin through his clothes, until they become so filled with it that we can smell it as we pass him on the street.

The smoker, however, may be entirely unconscious of this. His senses may be so blunted that he fails to notice the odors that make him offensive to many people with whom he has to do.

QUESTIONS FOR REVIEW

1. In respect to getting rid of waste matter, how may the body be compared to a stove or furnace?

2. In what four different ways does the body get rid of its waste matter?

3. In a general way, what may be said about the skin?

4. Describe the true skin.

5. How will you describe the scarfskin?

6. Show how we get rid of the outer layers of the scarfskin.

7. What gives the skin its color?

8. How will you describe the sweat glands?

9. Give in full the work done by the sweat glands.

10. How does the weather affect the work of the sweat glands?

11. What are oil glands?

12. Why do we need to keep our bodies clean?

13. What are the effects of stopping the drainpipes of the body?

14. Show how the skin may absorb helpful things.

15. How may poisons be absorbed by the skin?

16. Give in some detail the facts about Jenner's discovery of vaccination.

17. Give some reasons why we need a clean skin and clean clothes.

18. What hints can you give on taking a bath?

19. Give some practical points on swimming.

20. Describe the hair in some detail.

21. Why should the hair be kept clean?

22. What gives the hair its color?

23. What illustrations on this point can you give?

24. Describe the nails, and give some hints about their care.

25. What is the effect of tobacco on the skin?

CHAPTER XI

HOW OUR BODIES ARE KEPT WARM

228. How we know that we are warm. — Everybody knows that our bodies feel warm to the touch. If we get into a cold bed on a winter's night, the body soon warms it. However cold we feel at first, the heat of our bodies, like a fire always burning, keeps up warmth in the bed.

Put a doctor's thermometer under your tongue, and close the lips around it for five minutes. What do we find? On taking out the instrument we find that the natural heat of the body is between 98° and 99° Fahrenheit; that is, the temperature of the body is always the same, whether on the coldest day of winter or the hottest day of summer. Of course the skin may feel hot or cold at different times, but in health the temperature of the body within is kept the same.

Where does this heat come from? How does the body make this heat? It will help us to understand this to recall what we have already been told about air in Chapter IX.

229. How a Burning Candle produces Heat. — Oxygen, as we learned, easily unites with other things, and burns them. When oxygen unites with any other thing, it

always makes some heat. As the larger books tell us, this is called **oxidation**, or burning, whether there is any flame or not. When a candle is burning, the different things of which the candle is made unite with oxygen and make carbon dioxide.

There is another gas in the candle, called hydrogen, which unites with oxygen and forms water. This burning goes on very fast indeed, and makes the candle hot.

230. How our Bodies produce Heat. — In some ways we are much like a candle. We know there is plenty of carbon in our bodies, and also plenty of hydrogen; when the oxygen of the air unites with these they burn, as a candle does, only much more slowly, and turn into carbon dioxide and water, thus producing heat.

Since these things do not burn so fast in the moist tissues of the body as they do in the candle, therefore we do not flame and blaze up, and we are not nearly so hot as a lighted candle.

A piece of fat, for instance, burns rapidly and brightly when put into the fire. If we eat a piece of fat, it will make just as much heat within our bodies as if we burned it in the fire. True, the burning will not be so rapid, but it will last a much longer time. The total quantity of heat given out will be the same in both cases.

Hence the tissues of our bodies, especially the muscles, are all the time producing heat, because they are burning away bit by bit, just as a candle does. Every time we

move, feel, think, or, in fact, do anything at all, this burning goes on. Now, if heat is especially produced in the muscles, it is plain that the more we work with them the warmer we shall be. This is true, and this is why we throw our arms about and stamp our feet when we are cold.

Experiments. — Borrow a physician's clinical thermometer, and take your own temperature, and that of several friends, by placing the instrument under the tongue, closing the mouth, and holding it there for five minutes. Read it while in position, or the instant the instrument is removed. The natural temperature is about $98\frac{1}{2}°$ Fahr. The thermometer should be thoroughly cleansed after each use.

A substitute for a clinical thermometer may be readily contrived by taking an ordinary house thermometer from its tin case and cutting off the lower part of the scale so that the bulb may project freely.

The little thermometers often found on calendars and advertising circulars may be used, although the bodily temperature will not be shown accurately.

FIG. 106. — Schoolboy taking his own Temperature with an Improvised Thermometer

(From a photograph taken in the class room)

With these instruments the pupils may take their own and each other's temperatures, and it will be found that, whatever the season of the year or the temperature of the room, the thermometer in the mouth will record about 98° Fahr. Care must be taken to keep the thermometer in the mouth till the fluid ceases to rise.

231. How the Bodily Heat is regulated. — How is it that the warmth of the body is the same at every season of the year and in every climate?

If we put a drop of cold water on the back of the hand we feel the skin there grow colder; this is because the heat required to evaporate the liquid is taken from the skin. As the sweat evaporates from the skin, it carries off heat and leaves the skin colder.

The hotter the air outside of us, the more we sweat; but as fast as the sweat oozes out of the pores it evaporates, and so cools the skin. Thus in health the heat of the skin and the blood is kept from rising above its natural temperature.

FIG. 107. — Showing the Activity of the Sweat Glands

Experiment. — A simple experiment may illustrate the activity of the sweat glands. Hold the forefinger (when the body feels cool) very close to a cold mirror. A moist spot soon appears on the glass. This is sweat which has oozed out of the pores of the finger and collected on the cool mirror.

232. Effect of Occupation upon Bodily Heat. — If the air outside is very cold, the pores contract, and very little sweat oozes out of them. Thus in summer, and in hot countries, the abundant sweating tends to cool our bodies; while in winter and in cold countries, since little

sweating takes place, the body does not lose much heat. Men who have to work around great hot furnaces, as in iron foundries and glass works, are no hotter inside their bodies than those who handle ice during the winter months, or work in cold storage rooms.

Persons have been known to go without injury for a few minutes into ovens hot enough to bake bread. Years ago there was a man called the "Fire King," who could go into a very hot oven and stay five minutes. It was found that while he was in the oven the temperature of his blood was exactly the same as when he entered it. We may be sure that he used to sweat profusely.

Young girls in France who work in the bake shops go into large ovens when they are very hot, in order to attend to the loaves of bread.

233. Effect of Climate upon Bodily Heat. — The blood may become hotter or colder from causes within us, — for instance, fevers make it hotter; want of food makes it colder, — but it has the power of resisting the heat and the cold outside the body.

People are able to live in all climates because the blood always keeps at about the same degree of warmth, whatever the heat or the cold outside.

The Eskimo, who lives amid the ice and snow of polar regions, has as much warmth in his blood as the African, who lives under the scorching sun of the tropics.

234. Why we need Clothing. — Nature gives us thin and delicate skin as our only covering. Why do we need any other? Why do we need clothing?

In ordinary weather our bodies are, as you know, much warmer than the air out of doors, so they are continually giving out their heat to the air. Heat is lost from the body in several ways, — as in the air we breathe out, — but chiefly from the skin. When the bare skin is exposed, we lose heat rapidly, and feel chilly and cold; hence we wear clothes to keep the heat of our bodies from escaping too rapidly into the air.

There are other reasons. In summer, especially in hot countries, the direct rays of the sun tend to burn the skin. Again, clothes save the skin from being torn or hurt by accidents. They also keep out the wet, so that we can better endure exposure to rain or snow. The frequent changes of weather so common in this country are a severe tax on the body, against which our clothes are our chief protection.

235. How Climate and the Season of the Year should modify the Kind and Quantity of Clothing. — The clothing should be changed according to the climate or season of the year. It is not prudent to change winter clothing for that of lighter weight too early in the spring.

Woolen clothing, or clothing made of some closely woven material, is a good protection against sudden changes in all seasons.

A most imprudent but common error is to leave off winter flannels because of a few warm days in early spring. With the sudden changes of weather, a person thus runs great risk of taking a severe cold, which may result in pneumonia or "quick consumption."

A wise doctor has said, "Never allow yourself to feel cold. Whenever you feel chilly put on more clothing, go into a warmer room, or exercise. In some way get warm and keep warm. Only beggars and fools go cold. The former because they lack clothes; the latter, because they do not know enough to wear them."

236. Frequent Change of Clothing. — We should change often not only the garments used for daily wear, but also the bedclothes and nightclothes. We should not sleep in the clothes we wear during the day. Undergarments should be frequently and regularly changed. Bedclothes should be exposed freely to the light and air.

The germs of contagious diseases may be carried by the clothing. Hence the utmost care must be used in changing and disinfecting the clothes when brought in contact with people suffering from these diseases.

237. Care in clothing Children. — Great care should be taken with the clothing of children. They are less able than grown-up people to resist cold and sudden changes. The legs and chests of children should not be exposed to the bitter cold of winter, nor to the chilly winds of spring.

Children should wear proper outside garments on going out, and take them off on coming indoors. Pupils should not sit in the schoolroom with outside garments on, such as waterproofs, gossamers, cloaks, rubbers, rubber boots, and leggings.

NOTE. — In the clothing of children a line must be carefully drawn between prudence and coddling. To overclothe the body of a child in whom the production of heat is great, to overheat his nursery, and to prevent him roughing bad weather are the ways to court disaster. Development of the brain, the eye, the muscles, only comes with use, and so is it with the vigor of the circulation and the power to withstand and enjoy cold and hardship. — HILL'S *Physiology for Beginners*.

238. Caution against wearing Wet or Damp Clothing. — Wet or damp clothes should not be worn any longer than necessary. Little harm results from wearing wet clothes, provided the person keeps actively moving about until they can be changed. If we are exposed and get wet, we should take the shortest way home, remove the damp garments, rub down thoroughly, and put on dry, warm clothes. Always change at once damp skirts, wet stockings or shoes. Neglect of these matters often exposes one to needless risk of life and health.

239. Effect of using Alcoholic Beverages in Cold Weather. — Cold causes the blood vessels of the skin to grow smaller. This is Nature's way of economizing the heat of the body by allowing less blood to go to the surface,

where it would be more quickly cooled than in the interior of the body.

The skin feels cold when so much of the warm blood is thus shut away from it, and this also is Nature's way of giving warning that more heat is needed. If the person thus warned goes where the air is warmer, or puts on more clothing, or produces more heat in his body by exercise, he will soon become warmer.

240. Ill Effect of trying to keep warmer by using Strong Drink. — If, instead, he should try to warm himself by taking some kind of alcoholic drink, he would thwart Nature's plans. Alcohol causes the blood vessels in the skin to open wider. More blood, instead of less, flows to the surface, where it is cooled and thus makes the whole body colder. But the skin may feel warmer because it is for the time bathed in more warm blood. So no warning is sent to the brain, and the drinker does not properly guard himself from cold. In this way many persons who have thought to warm themselves by taking an alcoholic drink have been badly or fatally frozen.

241. Effect of using Alcohol in Hot Weather. — But how is it on a hot day or in a hot climate? Will not alcohol then help to cool the body by expanding the blood vessels and allowing more blood to flow from the interior to the surface and be cooled?

Here again Nature, if left alone, takes the proper means for protection. Heat causes the blood vessels to

expand and allow the blood to come to the surface. Perspiration flows out upon the skin, which is cooled by the resulting evaporation.

The heat also causes the muscles to relax, and the person does not feel like taking exercise. He also feels uncomfortable when out in the hot sun, and this leads him to seek a cooler place, or to protect his head from the sun's rays if he has to go out.

If, however, he takes some alcoholic drink, with the idea that it will cool him, he again thwarts Nature. The alcohol blunts his feelings, so that he is less conscious of the heat and hence is less careful to protect himself. It may tend also to excite him for a little while to unnecessary muscular exercise, which increases the heat of his body. It is likely also to weaken his self-control and lead him to take more drink, which still further unfits his senses for their duty. All this makes him more liable to sunstroke or heat exhaustion.

QUESTIONS FOR REVIEW

1. How do we know that our bodies are warm?

2. How may the heat of the body be shown by a doctor's thermometer?

3. Explain briefly how a burning candle produces heat.

4. Show very briefly how our bodies produce heat.

5. Explain in a general way the difference between the burning of a candle and that of our own bodies.

6. Show how this burning, or oxidation, is going on in the tissues of the body every moment of our lives.

7. How is the heat of the body regulated?

8. What is the effect of one's occupation upon the bodily heat?

9. Show how the bodily heat is modified by climate.

10. Give some facts gathered from your own reading to illustrate the effect of occupation and climate upon the heat of the body.

11. How does the body lose heat?

12. Give in some detail the various reasons why we need clothing.

13. Explain how the kind and the amount of clothing is modified by the climate and the season of the year.

14. What can you say about frequent changes in clothing?

15. How can you avoid spreading disease germs through the clothing?

16. What care should be taken in the clothing of children?

17. What caution should be used in regard to wearing wet or damp clothing?

18. What are some of the ill effects of using alcoholic beverages in cold weather?

19. Describe the ill effects of trying to keep warm by using strong drink.

20. What are some of the effects of using alcoholic liquors in hot weather?

CHAPTER XII

THE NERVOUS SYSTEM: HOW IT GOVERNS THE BODY

242. Each Part of the Body depends upon Some Other Part. — If we stop to think of it for a moment, we see how true it is that each part of the body depends upon some other part. We have learned in the preceding chapters that the various organs of the body work together for a common good. Thus if we make believe to strike suddenly at the eye of a playmate, his eyelids shut to protect it. If we tickle his foot when he is asleep, the muscles of his leg will pull it away.

Have you ever seen a gang of men, under a foreman, at work upon a tall steel office-building? Each man is trained to work in harmony with every other workman for a common purpose. So it is with the body, — all its other organs are regulated and controlled by the **nervous system.**

243. The Two Great Divisions of the Nervous System. — It will help us to learn a few simple facts about the nervous system if we divide it into two great divisions:

The first division includes the **brain**, the **spinal cord,** and the **cerebro-spinal nerves**, and is called the **cerebro-spinal system.** This is the great nerve center of the body.

The second great division is the **sympathetic system**, of which we shall presently learn.

244. The Brain. — The **brain** is one of the most wonderful and important organs in the body. It fills the inside of the skull, and is a curious, pulpy-looking mass. The outer surface is grooved into folds, in appearance not unlike a crumpled silk handkerchief.

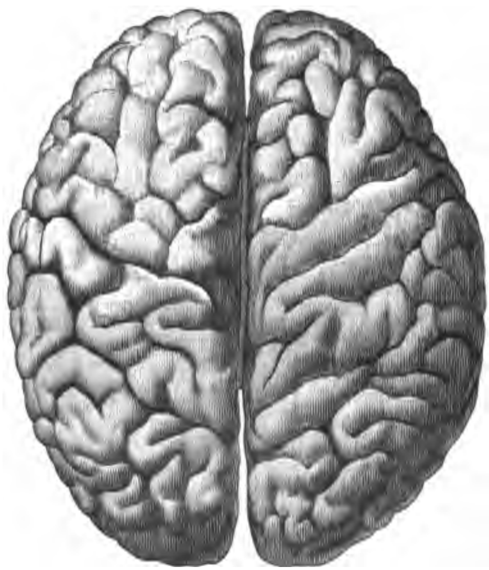

FIG. 108. — The Upper Surface of the Brain, showing its Division into Two Hemispheres, and also the Convolutions

The brain consists of two principal parts: one is large, the other is small.

The larger, or upper portion, the brain proper, is nearly seven eighths of the whole mass. It is in halves, one on each side, which are separated from each other by a deep groove. It is called the **cerebrum.**

The smaller part, or little brain, lies beneath the back part of the brain proper, and is called the **cerebellum.** It is about as large as a medium-sized orange.

245. The Weight of the Brain. — How much do you suppose the average brain of a man weighs? About three pounds. As a rule, a large brain is the sign of a superior mind. Daniel Webster's brain weighed fifty-three and a half ounces. Agassiz's weighed the same. That of Cuvier, the celebrated naturalist, weighed sixty-four and a third ounces. An idiot's brain rarely exceeds thirty ounces.

246. The Spinal Cord. — We may have seen in some market the **spinal cord**, or marrow, in the halved carcass of a sheep. It is a mass of soft tissue, which is packed in the bony canal of the backbone. We may think of our own spinal cord, which is as thick as one's little finger and from fifteen to eighteen inches long. It extends from the base of the skull to the loins, where it tapers to a point. It is protected from injury, jolts, and jars by its bony canal.

The spinal cord is the chief channel through which all messages from the trunk and limbs pass *to* the brain, and all orders or messages to the trunk and limbs pass *from* the brain.

Experiments. — The teacher may give pupils a very general idea of the brain by employing a butcher or marketman to dissect away the skin and muscles, saw open the skull, and save uninjured the brain of a sheep or a calf.

In like manner the general build of the spinal cord may be shown by getting at the market an uninjured piece of the spine of a sheep or a calf. A fresh brain or spine should be first soaked in some hardening fluid, as they are too soft for handling in class use.

247. The Spinal Nerves. — The backbone, as we have been told, is built of thirty-one separate bones, piled one on top of another. Between each one of these bones and the next a pair of nerves is given off from the spinal cord. These nerves are called **spinal nerves.** With their branches they extend to almost every part of the body.

The spinal nerves are conductors, which carry messages to and from the brain. They themselves do not issue orders, and they feel no sensations.

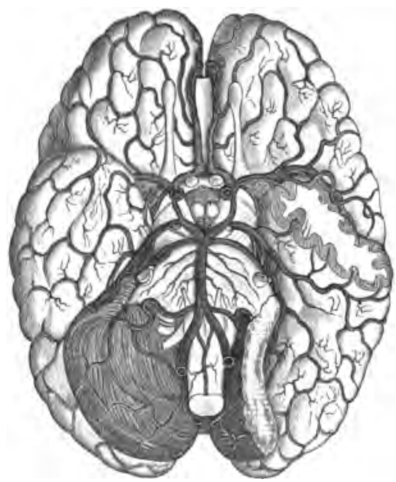

FIG. 109. — The Under Surface of the Brain, showing Some Large Arteries and their Branches

248. The Cranial Nerves. — Besides the thirty-one pairs of spinal nerves there are twelve pairs of nerves which spring directly from the base of the brain, and pass out through the floor of the skull. They are called **cranial nerves.** These nerves are distributed over the face and chest, and also send branches to the lungs, heart, and other organs.

249. The Sympathetic System. — On each side of the spine, from the brain even to the end of the backbone, is a chain of tiny oval masses of nerve cells, not unlike grains of wheat, called **nerve knots**, or **ganglia.**

These ganglia and their branches make up the **sympathetic system.** A large number of its nerve branches are given off to the heart, to the stomach, to the liver, to the intestines, and to other important organs.

FIG. 110. — The Main Trunk of a Great Cranial Nerve, showing its Distribution by its Larger Branches to the Windpipe, Heart, Lungs, and other Regions. The Windpipe and Descending Aorta are also shown

We may think of the ganglia as stations along the line of a great telephone system. Through these stations a single message may be sent off in a dozen directions, or a dozen ingoing messages may be gathered up and passed along a single nerve fiber to the spinal cord.

250. Work done by the Sympathetic System. — The general nervous system has in the sympathetic nerves a kind of independent telephone plant which serves as a helper in watching over those processes that are beyond the control of the will.

Thus, when food is taken into the stomach, messages are sent to and from various organs. The stomach takes on its churning motion, various glands begin their work, and certain blood vessels are dilated.

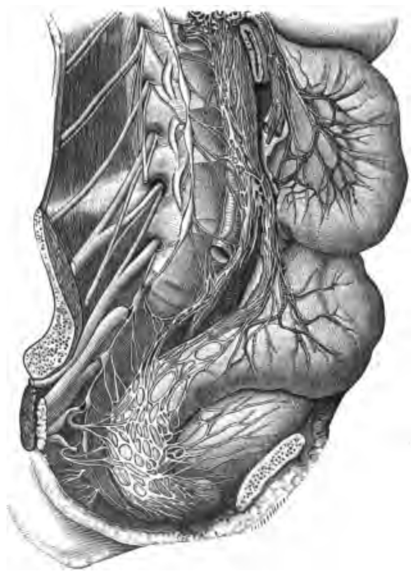

FIG. 111. — The Distribution of Some of the Great Nerves of the Sympathetic System to the Intestines. Several Spinal Nerves as they issue from the Spine are also shown

The sympathetic nerves thus serve as a means of putting various organs in touch with each other. Various emotions may act upon the sympathetic nerves. Thus, the sight of an accident may excite vomiting.

The different organs of the body are thus enabled to work in harmony for a common purpose. For this reason the name "sympathetic" is given to this part of the general nervous system.

251. The Telephone System in our Bodies. — We may compare the brain and the nerves in a general sort of way to a complete telephone system. The brain is the central office. The thousands of nerve fibers, branching off to all parts of the body, are the telephone wires.

Messages are constantly being sent to the brain to tell it what is going on in various parts of the body. The brain, on receiving the news, at once sends back its orders as to what must be done. The order flies through the nerves faster than it is possible for us to think.

Thus, in playing with a ball, the boy sees it coming toward him. A message is telephoned along the nerves from the eyes to the brain, "The ball is coming." The brain at once telephones a message to the muscles of the arms and legs, "Move quickly and catch the ball." In obedience to this order the muscles contract and the necessary motions are made for catching the ball.

252. Reflex Action. — Every message from various parts of the body does not travel as far as the central office, — that is, to the brain, — but some of them are switched off, or "reflected" as we call it, at some of the stations on the circuit.

These way stations, located along the spinal cord, receive messages and send back answers without orders from the central station, or the brain. If somebody should tickle our toes when we were fast asleep, we should draw our feet away; and yet we should know nothing about it when we awoke.

In eating, sometimes a bit of food will go down what is called the "wrong way," and we cough hard to get rid of it. We cannot help coughing; it goes on without our will. This is called a **reflex action.** The impressions made

by the tickling and the crumb do not have to go as far as the brain to receive attention. The signal of danger or distress goes first to one of the way stations in the cord or the part of the brain that adjoins the cord. The order to do something is then sent out, or "reflected," to the muscles which control the part in need of help.

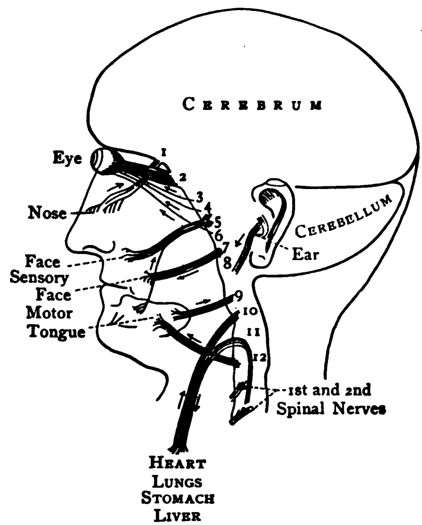

FIG. 112. — Diagram showing the Distribution of the Cranial Nerves

253. The Importance of Reflex Action. — Thus reflex action is very important to our health, comfort, and safety. A thousand acts take place which tend to keep us well, and yet we have as little control over them as over the stars above us. If the feet slip, the body tends to recover itself without the effort of the will. We try sometimes to brush the flies away when we are asleep. If we raise our hand suddenly to the eye, the eyelid closes to protect it.

The story is told of an old soldier who, while carrying a bowl of soup across the street, suddenly dropped it on hearing some wag call "Attention," so used was he, at

that word of command, to stand erect with his hands at his side.

254. How the Brain is relieved by Reflex Action. — What good is done by reflex action? It would take a larger book than this to tell the story. By this wonderful provision our brain is relieved of a vast amount of work. After one has once learned to walk, swim, skate, or ride the bicycle, the movements are carried on without an effort of the will. If we were forced to use our will power to digest our food we could not, as now, eat and then go about our business.

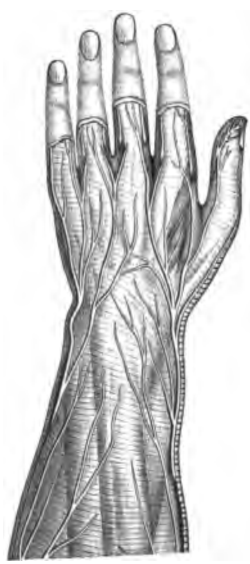

FIG. 113. — Superficial Nerves on the Back of the Left Forearm and Hand

255. The Need of Exercise for the Brain. — The brain, or the thinking part, is a most precious gift. It needs exercise as well as any other organ of the body. As its duty is to think, we should give it good things to think about, just as we give the stomach good food to digest. How necessary it is to keep it sound and healthy!

We should get the brain into the habit of thinking in earnest, so that it may grow strong and vigorous. A gentleman once asked a boy who was idling about the

fields, "What are you thinking about?" — "Mostly naught, sir," said the boy, and so it would be with many young people if they were left to themselves, and not taught from their infancy to think.

FIG. 114. — The Superficial Nerves on the Left Side of the Neck and Head

256. Overworking the Nervous System. — The nervous system may be easily overworked. This may occur not so much from hard study as from worry or over-anxiety about passing school examinations, from going to bed too late, or from giving too much time to the demands of society. These and many other imprudent habits of living often lay the foundation for years of ill health.

257. Sleep. — Of all the wonderful things about us which we do not wonder at because they are so common, sleep is one of the strangest. How it comes, why it comes, how it does its kind, helpful work, not even the wisest people are able to tell us. We do not have much

trouble in seeking it: it usually comes to us of itself. It takes us in its kindly arms, quiets and comforts us, repairs and refreshes us, and turns us out in the morning quite like new people.

258. How many Hours shall we sleep. — The amount of sleep which we need in order to do hard work and to keep well and strong depends upon a number of things. No exact rule can be laid down, but the amount varies with our age, occupation, and temperament. For example, a healthy baby usually spends the greater part of the first few weeks of its life in sleep.

Most of the world's great workers have required a goodly amount of sleep. Sir Walter Scott, who wrote "The Lady of the Lake" and "Ivanhoe," and Henry Ward Beecher, the famous eloquent clergyman, used to insist upon having eight hours of sound sleep every night.

Napoleon Bonaparte and Frederick the Great were tireless workers, and yet never slept more than four or five hours out of the twenty-four. These two remarkable men must, however, be regarded as exceptions to the ordinary rule.

259. Why Children need much Sleep. — Growing children need more sleep than grown-up people because their bodies need more rest during the period of growth. Hence children should go to bed early and sleep in the morning till they wake of themselves. We all know how

an active child is refreshed, especially during hot weather, by a bath and a long nap in the middle of the day.

Children should not go to bed when the brain is too active or excited. Hence quiet and restful talk and gentle games just before bedtime are much better for most children than weird goblin stories and hard play.

FIG. 115.—A Branch of One of the Cranial Nerves which supplies the Lower Teeth

Branches distributed to various muscles are also shown

260. Hints about Sleep.—When we are fairly awake we should get out of bed. Dozing in bed is not good for young folks. We should remember what the Duke of Wellington used to say: "When it is time to turn over it is time to turn out."

Avoid sleeping in a warm room. Pure, fresh air is necessary for sound, healthy sleep. We can open a window a little way in our bedrooms with safety almost every night, even in the coldest weather. Do not study hard or eat hearty food just before going to sleep. Do not think that "cat naps" during the day can ever make up for sleep lost at night.

261. Narcotics. — He would be a very unwise man who, after hiring a watchman to guard his property through the night, should give him a drug that would put him to sleep or make him so weak that he could not resist if a robber should come.

The nervous system is the guardian as well as the ruler of the body. And yet there are people who thoughtlessly take into their bodies substances whose nature it is to stupefy or weaken the nervous system. Such substances are called **narcotics**. Alcohol, tobacco, opium, and other substances of like nature are narcotics.

262. General Effect of Alcohol upon the Nervous System. — The alcohol in beer, wine, brandy, or other alcoholic drink has the power to cause more or less serious disturbance of the nervous system. If the amount used is small, the drinker himself may be scarcely aware of any effect, except, perhaps, he may feel somewhat excited. Yet close observation, or expert tests, after the use of amounts often considered moderate, may show that his brain works less carefully or correctly. He is not so quick to see the difference between right and wrong. He is less careful to refrain from words that will give offense. His power of self-control is weakened.

Such disturbance of the nervous system, if frequently repeated, tends to change the character of the individual. This change may show itself in different ways, such as neglect of business, ill temper, or cruelty.

263. Effect of Strong Drink upon the Judgment. — That faculty of the mind that decides what is good sense, what is right, wise, and best, is called the judgment. Alcohol takes the edge off the judgment. A person whose brain is excited with alcohol will laugh and be greatly pleased with what is in reality foolish, silly, and unwise.

Under this misleading excitement many persons have uttered words and done deeds that filled them with shame when they were told of them after the effects of the alcohol had passed off. Many a life that might otherwise have been one of happy usefulness has been permanently disgraced by some act done in this excited condition, when alcohol had dulled the sense of right.

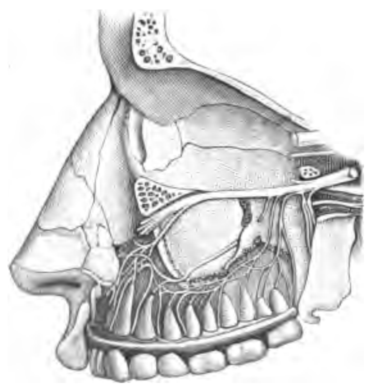

FIG. 116. — A Branch of One of the Cranial Nerves which supplies the Upper Teeth

Many and many a success in life has been lost because he who should have been the man of the hour was unfit for duty from having dulled his brain with alcohol.

264. Effect of Alcohol upon the Will. — When a person does what he undertakes in spite of difficulties, we say he has a strong will. Without such a will, rightly guided, no one can accomplish much in life.

FIG. 117.—Nerve Trunks of the Right Arm, with their Accompanying Arteries

One of the most serious dangers in the use of alcoholic drinks is the power of alcohol to weaken the will. The drinker often sees that alcohol is injuring his health and character, that it is making him careless about doing right, attending to business, and caring for those dependent on him. Conscience urges him never to take another drop. He solemnly resolves that he never will. Does he carry out the resolve?

265. Indulgence in Alcoholic Beverages lessens the Power to resist Temptation.—In the hours of temptation that are sure to follow indulgence in alcoholic beverages, the drinker needs a strong will with which to say No, and to keep on saying No very firmly, to the appetite that asks for more.

But alas! if the alcohol that created this appetite has also weakened the will of the drinker, he is far more likely to say Yes than No.

The person who is asked to take his "first glass," as well as the

occasional drinker, should remember that this appetite and weakened will are the natural consequences of the use of alcoholic liquors, and that the time when a person could stop drinking if he would leads on to the time when he would stop drinking if he could.

One of the sad facts about the use of alcohol is that drinking parents are not so likely to have strong, healthy children as those are who avoid all drinks containing alcohol.

FIG. 118.—A Great Nerve and its Branches on the Front of the Thigh

The femoral artery with its cut end is also shown

266. The Use of Tobacco.—Tobacco is another narcotic which tends to make the brain and nerves less keen and quick in their action.

The injury done by tobacco varies according to the quantity used. Even moderately used it is often hurtful, especially to young persons, and the tobacco habit, once acquired, is difficult to break. The appetite for it grows with its use. The fact that the habit is foolish, costly, and ill becoming is evident to every one.

267. Smoking Cigarettes.—The boy who smokes cigarettes will find, if he takes careful notice, that it is often

difficult to give close attention to his work. His ability to think clearly is injured by the tobacco. Even in sports, the boy who does not use cigarettes has more of the keenness, the alertness, and the strength that win.

FIG. 119.— A Great Nerve and its Branches which supply the Bottom of the Feet

The cut tendons of the great muscles of the leg are also shown

Many business men refuse to employ boys who smoke tobacco, because they know from experience that such boys are less reliable than those who do not smoke.

268. The Use of Tobacco from a Moral Point of View. — Tobacco has the power, through its effect upon the brain and nerves, to deaden the user's sense of politeness and make him careless of the rights of others.

All have a right to breathe pure air. The smoker puffs his tobacco smoke into the faces of people on the street cars and ferries, in waiting rooms, hotels, and places of amusement, regardless of the fact that it may be very disagreeable.

The tobacco chewer, selfishly thinking of no one but himself, soils the floor, stairs, sidewalks, and even stoves and other objects that come within the range of his disgusting habit.

This is the whole story in a nutshell: No person who wishes to keep strong and vigorous, or who is ambitious to succeed in life and to make the most of his abilities, should smoke, or use tobacco in any form.

NOTE. — The honors of the great schools, academies, and colleges are very largely taken by the abstainers from tobacco. This is proved by the result of repeated and extensive comparisons of the advanced classes in a great number of educational institutions in this country and in Europe. Our military and naval academies and very many seminaries and colleges very properly prohibit the use of tobacco by their students. The laws of many states rigidly forbid the sale of tobacco, especially of cigarettes, to minors. — BLAISDELL'S *Life and Health*, page 236.

269. Opium. — Opium is a very dangerous narcotic. It is the dried juice of the white poppy. Morphine is a white powder made from opium. Laudanum is a solution of opium in alcohol. Paregoric is a weak form of opium, combined with other things.

Opium is becoming as great a curse to some of the natives of Asia as alcohol and tobacco are to the people of Europe and America. But its use is gaining ground even in this country, and for this reason all should know that it is a dangerous narcotic, with power to create an appetite for more.

Various forms of opium are generally used in liniments, cough killers, soothing syrups, and other advertised medicines. Few people who use these realize that they contain opium.

A person may begin in the most innocent way to take these or other forms of opium to relieve pain; but no one is safe who thus tampers with this dangerous substance. Little by little, before he realizes it, he may form the craving for opium, which it may be almost impossible to resist. The opium habit soon ruins health and character.

Opium is often given to infants and children in the form of the so-called soothing syrups, sleeping drops, and colic mixtures. The child seems to be soothed, but it is because he is stupefied, not cured.

270. Chloral and Other Powerful Drugs. — Chloral is a powerful drug, capable of producing sleep. People who use it for this purpose run the risk of becoming slaves to a dangerous habit. **Chloral** soon injures the health. The user is liable to become careless and take a fatal dose.

Many kinds of powerful drugs, sold under fanciful names and advertised to cure headache, "grip," and other ailments, are now widely used in households. There is an ever-present danger to health, and even life itself, in the common use of such remedies.

QUESTIONS FOR REVIEW

1. How does each part of the body depend upon some other part?

2. Illustrate this point by comparison with the work of a gang of men employed under a master workman in the erection of a modern steel office building.

3. What are the two general divisions of the nervous system?

4. Tell what you can about the brain and its various parts.

5. What do you know about the weight of the brain?

6. Describe in some detail the spinal cord.

7. What are the spinal nerves?

8. What are the cranial nerves?

9. Describe the sympathetic system.

10. What work is done by the sympathetic system?

11. How may we compare the brain and nerves to a telephone system?

12. Describe and illustrate what is meant by reflex action.

13. Show the importance of reflex action, giving illustrations.

14. How is the brain relieved by reflex action?

15. Why is there need of exercise for the brain?

16. How may the nervous system be overworked?

17. What can you say about sleep and the number of hours needed?

18. Why do children need much sleep?

19. What hints about sleep can you mention?

20. What is the general effect of alcohol upon the nervous system?

21. How may the judgment and the will power be weakened by strong drink?

22. What can you tell about the appetite or craving for alcoholic liquors?

23. What can you say about the use of tobacco?

24. What can you say about smoking cigarettes?

25. Describe the common forms of opium, giving a few practical points about their use.

CHAPTER XIII

THE FIVE GATEWAYS OF KNOWLEDGE

271. How the Brain learns what takes place in the Outer World. — Some nerves, as we have learned, control the muscles; others carry a variety of impressions to the brain from every part of the body.

When the brain receives an impression through certain nerves, we become conscious of a **sensation.** Exactly how a sensation leaves an imprint on the brain is one of the many mysteries which even the wisest men cannot explain.

Most sensations are usually produced by something outside of us. Thus, if we hear a locomotive whistle, a dog bark, or a child play on a piano, we have a sensation of sound. If we put salt on the tongue, hold a pink to the nose, pinch the skin, or gaze at a beautiful rainbow, certain organs receive the impressions. Faithful nerves then carry the impressions to the brain, and we thus become conscious of different sensations.

272. The Five Gateways. — There are five "gateways of knowledge," or avenues, through which we learn what takes place in the world around us. In other words, we have five special **sense organs,** — the **skin**, the chief organ

of touch; the **tongue**, of taste; the **nose**, of smell; the **ear**, of hearing; and the **eye**, of sight.

273. Touch. — The simplest of the senses is **touch**. It is given to some extent to the whole body; but it is more delicate in the hands and fingers than elsewhere. When we pass our fingers over an object, we say we feel it, and can tell whether it is soft or hard, rough or smooth.

If we look carefully at the palm of the hand or at the ends of the fingers, we can see tiny ridges and furrows. At the tips of the fingers these ridges go round and round in circles. If the finger tips be smeared with some thick ink, an impression can be made on paper, showing these circles or wavy figures.

In old times, before the art of writing, and therefore of signing one's name, was common, the old English kings would sign a document by inking the end of the thumb and stamping it on paper; hence, it is said, originated the phrase, "my hand and seal."

274. The Wonders of the Sense of Touch. — The sense of touch can be cultivated to a marvelous extent. Think what blind people can do! With what skill and rapidity do they learn to make baskets and brushes in the asylums! They read with ease by running their fingers over slightly raised letters, and recognize their friends by feeling their faces.

The story is told of an old blind man who lost both his arms, and as he had no fingers with which to read, he

learned to do so by his lips. Watch an expert blind pianist, and see the skill, the rapidity, and the precision with which he handles the keys of the instrument.

Animals are very sensitive to the sense of touch. Every boy who has kept rabbits knows how easily their hearts are won by gently tickling them behind the ears. A horse keenly enjoys the same kind of treatment on the tip of his nose.

275. Taste. — The tongue is the chief organ of **taste.** It has two coverings, — an outer layer, and a deep, sensitive layer. In sickness this outer layer often becomes coated with whitish or yellowish matter. The deep layer is raised up, like the true skin, into tiny hillocks, or papillæ, which are abundantly supplied with delicate nerves, — the nerves of taste.

The tip and back of the tongue are supplied with different nerves; hence it makes a difference whether we put a substance to be tasted on the tip or on the back of the tongue. Alum, for example, has an acid taste on the tip and a sweetish taste on the back of the tongue.

In certain animals these hillocks are very large and give a roughness to the tongue. We know that a cat's tongue is very rough, and it is this which enables her to strip off the flesh from a bone by simply licking it.

Bees and wasps have keen tastes. Ants detect at once any bitter stuff that may be put into honey. A hungry hen picks up kernels of corn and seems to

swallow them like so many bullets, but detects at once whether the corn is fresh or musty.

276. How the Sense of Taste may be modified. — Taste is a kind of picket guard at the gateway of the digestive canal. It is much modified by habit, education, and many other things. The Laplanders drink rancid fish oil with a relish; the ancient Persians used as an appetizer the offensive asafetida, which they called the divine perfume; and the Chinese are accustomed to season their salad with castor oil.

Great acuteness may be gained in the sense of taste. "Tea tasters" become wonderfully skillful in recognizing flavors of tea.

277. Smell. — The seat of the sense of **smell** is in the cavities of the nose, into which the nostrils open, and which connect behind with the throat, above the back part of the mouth. The walls of the nasal cavities are lined with a thick, velvety membrane, over which the nerves of smell are distributed.

This membrane is kept continually moist by a fluid which it secretes. When we have a cold in the head, as it is called, we are hardly able to smell anything. This is because this membrane is swollen.

The sense of smell is most acute in the roof of the nasal cavities; hence when we wish to detect a faint odor we sniff up the air sharply. A dog gives several short, sharp sniffs when smelling for game.

278. Acuteness of the Sense of Smell. — The sense of smell serves as a sentinel at the nose. It warns us against eating improper or unwholesome food and breathing impure air. It varies very much in different individuals and in different animals. In some persons it is very dull, while others have a very "sharp nose."

In savage races this sense is most acute. We are told that the South American Indians can by their sense of smell detect the approach of a stranger, even in a dark night.

This sense is far more acute in many animals than in man. A dog will smell the footsteps of his master amid those of a hundred other people, and can trace him for miles, although he has been long out of sight. Pointers also scent game at a great distance. Cats are greatly excited by the smell of valerian, which they easily detect in a tightly corked bottle. Certain insects hurry away in great distress from the odor of tar and camphor.

Experiments. — It is often difficult to distinguish between the sense of taste and that of smell. If we chew some pure roasted coffee, it seems to have a distinct taste. Pinch the nose hard while chewing it and there is little taste. Coffee has a powerful odor but only a feeble taste.

Light helps the sense of taste. Close the nostrils, shut the eyes, and attempt to distinguish by taste alone between a slice of apple and a slice of potato.

Pinch the nose, close the eyes, and note how palatable a few drops of cod-liver oil becomes.

279. Hearing. — We have ears which help us to keep in touch with the outside world. Next to sight, **hearing** is the most important of the senses. We could get along without being able to taste; but without seeing and hearing life would be almost a blank.

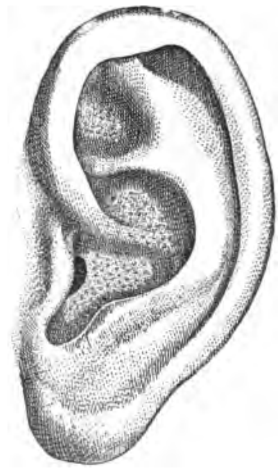

FIG. 120. — The Outer Ear

Animals that have a backbone always have the organ of hearing in the head. Birds have no outward ears, but they are very sharp at catching the call of their own kind, or the cry of a hawk. The cricket has ears, but they are on its legs. Our own ears have their delicate parts securely lodged in the bones on either side of the head.

280. The Outer Ear. — The **outer ear** is a piece of gristle covered with skin. It is curiously molded and serves as a sort of wind sail to catch sounds. In some animals it is quite large and movable; hence the timid rabbit and the intelligent horse "prick up their ears" to listen. The tube in the ear is about an inch long, and guides the sound inward just as an ear trumpet does.

At the lower end of this passage we find a delicate membrane stretched tightly across, which serves as a partition between the outer and the middle ear. It is

thin and elastic; hence it may be easily injured by a blow or by pushing some blunt instrument into the ear.

281. The Middle Ear. — The **middle ear** is really the ear. In form it resembles an ordinary drum. Three of the tiniest bones in the body stretch across it. They are so small that you can easily balance them on the tip of your finger. One curious thing is, that they are as large in infancy as they ever will be.

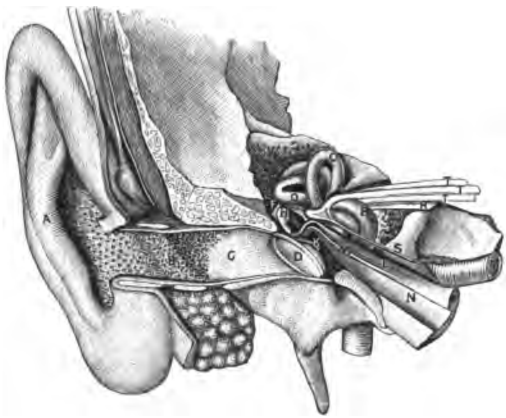

FIG. 121. — General View of the Organ of Hearing

A, outer ear; *B*, cavity of the outer ear, showing the openings of a great number of oil glands; *C*, outer entrance to the ear; *D*, tympanic membrane; *F*, *H*, *K*, bones of the ear; *L*, a small muscle; between *M* and *K* is the tympanic cavity; *N*, Eustachian tube leading to upper part of mouth; *O*, *P*, semicircular canals; *R*, internal auditory canal; *S*, large nerve given off from the facial nerve; *T*, facial and auditory nerves

The air reaches the inside of the eardrum through a little tube about an inch long, which leads into it from the throat. It serves to keep the air on both sides of the drum membrane at a constant and even pressure. Hence gunners open their mouths when a heavy cannon is about to be fired, so that the shock may be felt less forcibly. In going up a high

mountain, or under water in a diving bell, people swallow repeatedly to save the feeling of discomfort and pain in the ears.

282. The Inner Ear. — The **inner ear** is one of the most delicate and complex bits of machinery in the whole body. It is really a series of the tiniest winding chambers and spiral tubes hollowed out in the solid bone.

The nerve of hearing passes from the inner ear to the brain through a little hole in the skull. It is this nerve which carries sound to the brain.

283. Hints on the Care of the Ears. — Do not try to relieve a slight itching in the ears, or to remove ear-wax, with ear spoons, the ends of pencils, or hairpins, as there is danger of doing harm to the drum membrane of the ear. A drop of sweet oil, melted vaseline, or even molasses will dislodge any insect which may get into the ear. Do not go to sleep in any position by which the ears are exposed to a draught of cold air.

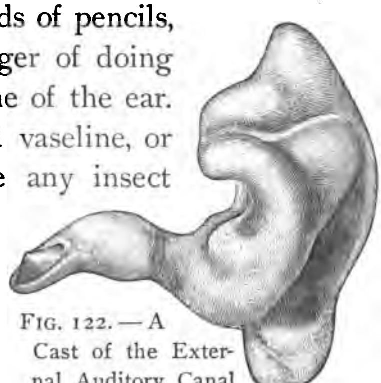

FIG. 122. — A Cast of the External Auditory Canal (Posterior view)

The ears are often injured by diving into deep water or bathing in the surf. Wads of absorbent cotton may be inserted into the ears to protect them in salt-water bathing. Never pull or box a child's ears. A slight blow may result in deafness.

284. Other Hints on the Care of the Ears. — Great care should be taken of the ears after an attack of scarlet fever or diphtheria. It is not at all uncommon to find that pupils who are thought to be dull or heedless are only hard of hearing.

Do not shout suddenly in anybody's ear. Deafness may result from the shock. Quinine, so commonly used in some form or other for malaria, often causes a deafness for the time. Earache, or pain in the ear canal, may result from decayed or imperfectly filled teeth.

Do not bathe the ear and nostrils with very cold water. Colds easily settle in the ear and throat passages. Never use any of the many articles or medicines advertised to cure deafness. Any trouble with the ear usually needs the advice of a doctor.

285. Sight. — The sense of **sight** enables us to learn what is going on in the outside world near by, or even many miles away. It is indeed a very precious gift, the most perfect and most wonderful of all our senses.

We watch a balloon from the time it leaves the ground till it is a black speck in the sky, and the next instant we may be reading the finest print of a story book.

The sense of sight is so concerned with the numberless acts of our everyday life that we are too apt to forget that it is essential not only to the simplest matters of comfort and pleasure but also to the culture of the mind.

286. The Eye and its Wonders. — The **eye**, a most beautiful and curiously planned organ, is the instrument of sight. It is really one of the greatest wonders of nature.

The eye, not unlike an egg in shape, is lodged in a cavity of the skull called the **socket**. It is well protected by strong bones, and rests upon a cushion of fat. We may think of it as a very precious gem resting in a nicely made case.

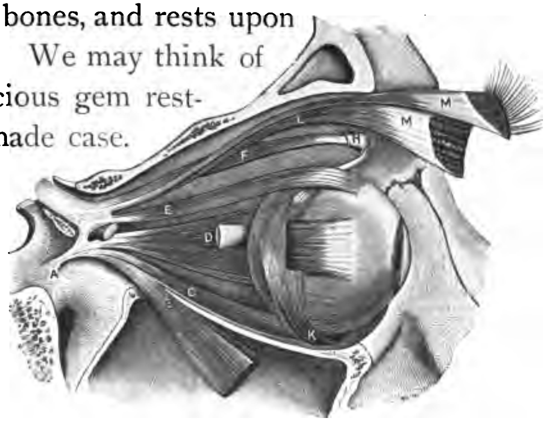

FIG. 123. — Muscles of the Eyeball

A, tendon of the four recti or straight muscles of the eye; *B*, one of the straight muscles cut; *C*, *D*, *E*, three of the straight muscles; *F*, a muscle which helps pull the eyeball sideways by means of the pulley at *H*; *K*, a muscle of the lower part of the eyeball which corresponds in action to *F*; *L* and *M*, muscles which raise the upper eyelid; to the right of *D* and to the left are seen the cut ends of the optic nerve

Passing to the brain through a crevice in the bottom of the eye socket is the **optic nerve**, which gives the power of sight. It spreads itself like a network upon the inner surface of the eyeball. It is then called the **retina** and forms the terminal organ of vision.

It is upon the retina that the pictures of objects are thrown. The impression of the pictures is carried to the brain, and causes the sensation of sight.

Sometimes the optic nerve is diseased, and total blindness results. The great poet John Milton suffered from this disease, and in his blindness dictated the immortal poem *Paradise Lost.*

FIG. 124.—Schoolboy trying an Experiment to find the Blind Spot

(From a photograph taken in the schoolroom)

Experiments. — The retina is not sensitive where the optic nerve enters the eyeball. This is called the "blind spot."

On a white card make a cross and a large dot about four inches apart. Hold the card vertically about ten inches from the right eye, the left being closed. Look steadily at the cross with the right eye, when both the cross and the dot will be seen. Gradually bring the card nearer the eye, keeping the eye fixed on the cross. At a certain distance the dot will disappear. On bringing the card still nearer the dot reappears, the cross, of course, being visible all the time.

The location of the blind spot may also be shown in the following simple manner. The left eye being shut, let the right eye be fixed on the letter A below. When the book is held at arm's length both A

A **O**

and the letter O will be visible; if the book be brought to about eight inches from the eye, the gaze being kept steadily upon A, O will at first disappear; but as the book is brought still nearer, both A and O will again be seen.

287. The Eyeball. — The **eyeball** is almost round, thick and dull everywhere except in front, where it has a transparent covering which fits into the eye much as a watch crystal is fitted into a watch.

Through this covering, or **cornea** as it is called, the rays of light pass into the ball of the eye. Behind the cornea is a space, called the **front chamber** of the eye, filled with a watery fluid.

288. The Iris and the Crystalline Lens. — In this front chamber of the eye there hangs a curtain called the **iris**, meaning "rainbow," which regulates the amount of light that enters the eye. This curtain, which may be black, brown, or blue, gives the color to the eye. It has through its center a round opening, called the **pupil**, which is for the admission of light.

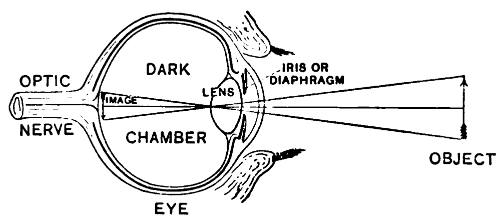

FIG. 125. — BLACKBOARD SKETCH

Diagram illustrating the Manner in which the Image of an Object is brought to a Focus on the Retina

Back of the pupil, and just behind the iris, is a transparent, jellylike body, about the size of a French bean. It is called the **crystalline lens**, and it helps the cornea bring the pictures to a point, or focus, on the retina.

The space between the crystalline lens in front and the retina behind is filled with a clear fluid.

The eye is able to move in its socket by means of a number of little muscles. Sometimes these muscles do not act properly; then the person is said to squint, or to be cross-eyed.

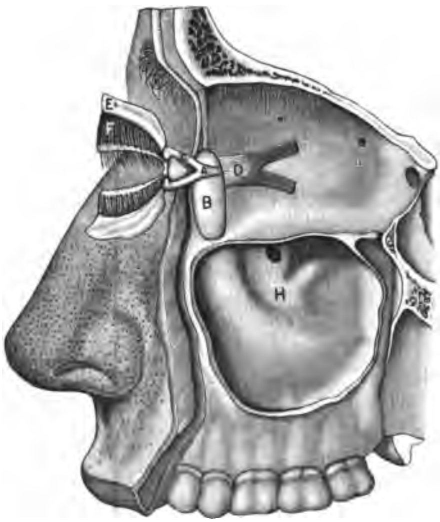

FIG. 126. — The Relative Position of the Tear Apparatus and the Eyelids

A and *C*, tear canals; *B*, tear sac; *D*, small muscle which serves to compress the tear sac; *E*, lining membrane of the upper and lower eyelids; *F*, glands upon the inner surface of the eyelids, with ducts opening upon the margins of the eyelids; *H*, great opening, or antrum, in the upper jawbone. The oil glands of the nose are also plainly shown

289. The Eyelids and Eyebrows. — Over each eye are little rows of hairs called the **eyebrows.** They add to the beauty of the face and help prevent the sweat from rolling down the forehead into the eyes.

The **eyelids**, by continual winking, protect the eye from insects and dust. They are fringed with delicate hairs called the **eyelashes,** which are so sensitive that the slightest touch gives warning and the lids close.

290. The Tears. — At the upper and outer side of each eye is a little gland called the **tear gland**, which is constantly forming a saltish kind of fluid. Sometimes more

of this fluid flows from this little gland than can be carried away through the nose, and it flows over the eyelids down the cheeks and is called **tears.**

Tears are constantly passing over the front of the eye, washing it clean and keeping it moist, while the eyelid wipes it dry, as it were, by forcing the tears into a little drainpipe, which carries them off into the nose. Nature, however, kindly oils the edges of the eyelids, to prevent, to some extent, the overflow of tears.

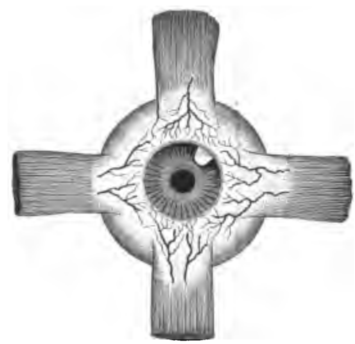

FIG. 127. — The Attachment of the Recti, or Straight Muscles, to the Eyeball, also showing the Distribution of Arteries upon the Outer Coat of the Eye

291. Near Sight and Far Sight. — One of the most common defects of vision is **near sight.** The axis of the eyeball is a trifle too long from the cornea to the retina. A blurred picture is made on the retina. Such a person is said to be nearsighted. It is a very common ailment during school life.

In **long sight** there is no distinct vision without some strain. The axis of the eyeball is too short, and the focus falls beyond the retina, which is too near the cornea. This kind of indistinct vision is quite common in childhood.

292. Color Blindness and what it means. — What does it mean to be color blind? Four or five out of every hundred people, it is said, are color blind.

Color Blindness is the inability to tell certain colors. It generally exists at birth. Some people are partly color blind, while others are wholly so. The most common form of this defect is that in which one fails to distinguish between red and green. We may be color blind and not know it until the defect is exposed by some accident.

The discoverer of color blindness was a famous chemist by the name of Dalton, who died some sixty years ago, and who himself was color blind, a fact which he found out only by accident.

We may be sure that it is a matter of great importance to detect color blindness in those employed on steam and electric railways, on shipboard, on automobiles, and in all other places where red and green signals are used.

293. Hints on keeping Good Eyesight. — Do not read in bed or while lying down in a darkened room. Avoid as far as possible books and papers printed on poor paper and in fine type. It is trying to the eyes to read with the sunlight falling on the book, or at or near dusk, or by a flickering light.

If the eyes tingle or smart, or the sight is dim or blurred, stop and rest. Reading early in the morning

by artificial light is a severe strain on the eyes of most people. Do not read, write, or sew, if it can be helped, when tired or sleepy.

294. Practical Points on the Care of the Eyes. — Do not rub or handle roughly the eyes when they are irritated by having something in them. The sooner the foreign substance is removed the better. Do not rub the eye or pull the eyelids. It is sure to make a bad matter worse. There is a quaint saying of the Germans that the eyes should never be rubbed except with the elbows.

The eyes are often weak, and should be most carefully used after an attack of scarlet fever, measles, or diphtheria. It is very trying to the eyes to be exposed to light reflected from snow. It is a severe test, even for the best eyes, to ride against the wind, especially on a bicycle or in an automobile. Much suffering to the eyesight is caused by neglecting to wear glasses when they are needed.

295. Effect of Alcohol and Tobacco on the Senses. — When a person has benumbed his brain with alcohol his senses are also dulled. A louder tone of voice is necessary in order to make him hear. He does not see distinctly. He may fall and bruise himself without complaining of pain.

How much less keen the senses are after alcohol is used than before depends partly upon the amount taken. Much less than enough to make a man drunk may cause

a weakening of the senses that will show itself if careful tests are made. The drinker himself is usually so deceived by the effect of the alcohol that he thinks his senses are keener and stronger when they are really duller and weaker.

296. Effect of Alcohol upon the Eyesight. — The ability to measure distance with the eye is very useful. The expert ball player is able to follow a ball with his eye when it is thrown high in the air, and to calculate so closely where it will come down that he is at the right place to catch it when it falls.

Experimenters who have tested the matter tell us that alcohol has the power to weaken the ability to measure accurately with the eye. It causes the drinker to make more errors in measuring with the eye than when he takes no alcohol.

The long-continued use of alcohol and tobacco, especially tobacco, often results in a disease of the eyes which may seriously impair vision.

QUESTIONS FOR REVIEW

1. How does the brain learn what takes place in the outer world?
2. What is meant by the "five gateways of knowledge"?
3. What are the five special sense organs?
4. Describe the sensation of touch.
5. What do you know about the wonders of the sense of touch?
6. Tell what you can about the sense of taste.
7. In what way may the sense of taste be modified?
8. Describe the sense of smell.
9. Give illustrations of special acuteness in the sense of smell.
10. Tell what you can about the outer ear.
11. Describe the structure of the middle ear.
12. Tell something about the inner ear.
13. Give some practical hints about the care of the ear.
14. What can you tell about the importance of the sense of sight?
15. Describe the general structure of the eye.
16. What can you tell about the eyeball?
17. Describe the iris and the crystalline lens.
18. Tell something about the eyelids, the eyebrows, and the tears.
19. What is meant by near sight and far sight?
20. Describe color blindness and state in what employments it may become a matter of great importance.
21. Explain the importance of detecting color blindness.
22. Give some hints on keeping good eyesight.
23. What other points about the care of the eyes can you give?
24. What may be the effect of alcoholic liquors and tobacco on the special senses?
25. How may alcohol affect the eyesight?

CHAPTER XIV

BACTERIA AND DISEASES THAT SPREAD

297. What the Microscope reveals. — Did you ever think how many of the secrets of Mother Nature are revealed by the microscope? This wonderful instrument enables us to see and study a whole world of living creatures which otherwise we should know nothing about. Everybody knew long ago that in hot weather milk, meat, and all kinds of moist food will quickly spoil.

The real reason why many things mold or sour was not known until the microscope told the secret. Now we know that these changes are caused by the work of untold millions of very small living plants.

298. Three Simple Forms of Plant Life. — The three simplest forms of plant life which we know about are **yeast**, **mold**, and **bacteria.**

Yeast, which is so much used in making bread, is a very tiny plant. It grows and multiplies very rapidly in heat and moisture. (Secs. 97 and 115.)

Mold is another kind of plant life, which we have all seen growing upon wood, leather, meat, and cheese.

NOTE. — Several other words, as **bacilli**, **germs**, **microörganisms**, and **microbes**, are terms commonly used for certain low forms of plant life of microscopic size.

Besides these two there is a third group of these invisible plants that contains some of man's worst enemies. The common name for this group is **bacteria.**

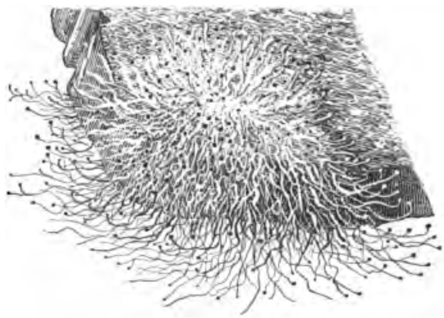

FIG. 128. — A Piece of Bread upon which One of the More Common Molds is growing

299. Bacteria. — We may think of **bacteria** as the smallest of living things. They vary greatly in form and size, but are always invisible to the naked eye. Some of them are merely round bodies strung together like beads. They are so small that twenty-five thousand would not reach across a ten-cent coin. Of another kind it is said that fifteen hundred put end to end would scarcely reach across the head of a small pin.

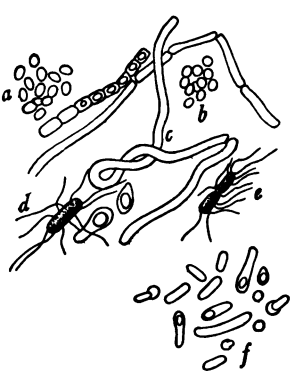

FIG. 129. — A Group of Bacteria found in Surface Soil

Bacteria are to be found almost everywhere upon the surface of the earth. They are in the water we drink, in the food we eat, in the air we breathe, and in the soil under our feet. Under certain conditions bacteria grow with incredible rapidity. It is said that one

single spore or egg can produce over ten million in a single day.

300. The Work done by Bacteria. — What good is done by the bacteria? They feed on decaying and dead matter and make it fit for the food of plants. They help make the face of the earth sweet and clean for its inhabitants to live upon. If it were not for bacteria the dead plants and the bodies of dead animals would cover the earth and put a speedy end to all life.

FIG. 130. — Scrapings from the Teeth, containing Several Different Kinds of Bacteria. (Highly magnified)

301. How Bacteria cause Disease. — Some kinds of bacteria are not content with feeding upon dead plants and animals, but they must attack or enter our bodies, and under certain conditions may cause sickness and death. Thus we may breathe certain bacteria into our mouths which may lodge upon the teeth and cause them to decay.

Some bacteria, like diphtheria germs, may grow in and around the throat, but during this growth they may manufacture certain poisons which are taken into the blood and carried into other parts of the body, causing disease and death. There is a certain kind of bacteria which lives in the earth. If it gets into the body it may grow and cause lockjaw. Other bacteria fall upon open wounds, produce inflammation, and stop their healing.

302. How Germs of Disease may be carried and received. — The germs of disease may be carried from one person or place to another and received, or "caught," in many different ways. This may be done by actual contact. Thus, if we caress a cat suffering with a ringworm on its body we may transfer some of the germs to our own skin, where they may grow into a ringworm. We know that the germs of scarlet fever and smallpox may be caught by handling clothing worn by persons sick with these dreadful diseases.

FIG. 131. — Bacilli of Lockjaw. (Magnified about 1000 times)

Certain kinds of bacteria may gain an entrance into the blood through a tiny scratch, or sore, or even by the prick of a pin on the skin.

FIG. 132. — Bacilli of Typhoid Fever. (Magnified 1000 diameters)

The germs of typhoid fever may be taken into the body with the water we drink and the food we eat. The typhoid germ has been found in ice and even in ice cream, and has also been traced to eating raw oysters that were fattened in water poisoned with sewage.

303. Dust and Bacteria. — Germs may stick to bits of dust in the air and cause disease. Our bodies furnish a good soil in which some of these floating germs may take root and grow under certain conditions. Germs of disease have been found in the air in Berlin, which were wafted in the dust blown from the great desert in Africa.

The careless sweeping and dusting of sick rooms and the brushing of unclean clothing and furniture scatter these seeds of disease into the air and they may be breathed into our bodies. The dried sputa of a person afflicted with consumption may be blown about in the dust of the street. The germs of this disease have been found in the hems of long dress skirts that have swept the streets.

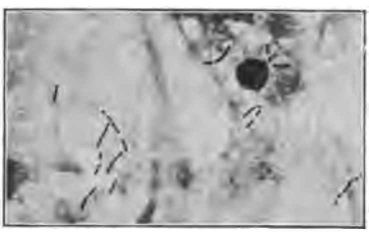

FIG. 133. — Bacilli of Tuberculosis

A minute portion of sputum from a case of phthisis, or consumption of the lungs, magnified 1000 diameters. These bacilli are rod-shaped bacteria, stained to show black. The black spots in the figure are merely the débris in the sputum, also stained so that they look black

304. How Our Bodies may defend themselves against Germs of Disease. — Of course you will want to know how we can escape from these unseen foes which may attack our bodies at any moment. Nobody can surely tell. Whatever wise men may think about it, it is true that if we are in sound health we

are less liable to be attacked by bacteria which bring disease than if we are in a weak condition from cold, lack of food, overwork, or indulgence in strong drink.

305. How Nature helps to prevent the Spread of Disease. — Our good Mother Nature has provided us with two powerful helps in preventing the spread of disease. These are **pure air** and **pure water.** Without them we could keep well only for a short time. The air of overcrowded and poorly ventilated rooms abounds in the germs of disease, while the air of the woods and the mountains is nearly free from them. Surface water, tainted with decaying vegetation, swarms with bacteria, but disease-producing germs are rarely found in the water of artesian wells.

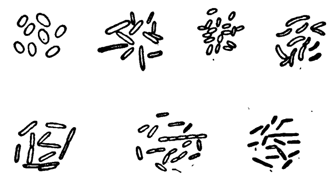

FIG. 134. — A Group of the More Common Bacteria found in Water

306. How the Health of the People is protected. — No attempt was made until a few years ago to protect people against the spread of disease. Perhaps some of us have read in our histories of the many outbreaks of pestilence and sickness in Europe in olden times. Nearly six hundred years ago more than one half of all the people in England died of Black Death. The death rate was the highest in the filthy and undrained streets of London. In the year 1665 one hundred thousand people died in London alone of the Great Plague. The

houses were overcrowded and wretched and the streets filthy. The Great Fire during the next year which burned over many acres in London proved a blessing in disguise. The people began to realize the value of cleanliness, fresh air, and sunlight. Thousands of lives in our large cities have been saved in recent years by the use of sewers, good drainage, and pure water.

307. Safeguards against the Spread of Disease. — There are several safeguards which are widely used to check the spread of contagious diseases. First, there is **vaccination.** Most of us know what it is to be vaccinated and thus to be protected against a severe attack of the loathsome and often fatal disease smallpox (Sec. 218).

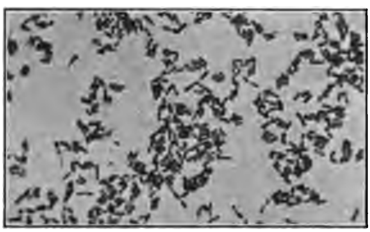

FIG. 135. — Bacilli of Diphtheria. (Magnified 1000 diameters)

Somewhat in the same way the diphtheria antitoxin, as it is called, is now introduced into the body to destroy the activity of the bacteria of this disease.

Another safeguard against the spread of contagious diseases is **isolation.** Those who have diphtheria, scarlet fever, and other "catching" diseases are kept apart from well people, a colored card of warning is placed upon the house, a rigid plan of nursing is carried out, and other means are used to take the best care of the sick and prevent further spread of the disease.

A third familiar safeguard is **disinfection**, which is now generally recognized as a practical means of destroying disease-producing bacteria.

308. Disinfection. — We often hear the word disinfectant used, and we should know exactly what it means. A true **disinfectant** is a substance which is used to kill bacteria and their seeds or spores.

There are some things which will only stop the growth of bacteria, but will not kill them. These are called **antiseptics.** Then there are other preparations which help to conceal disagreeable odors, but have no action whatever on the bacteria themselves. These substances are known as **deodorants.**

309. The More Common Disinfectants. — One of the best disinfectants is **heat** in its various forms. By its proper use bacteria may be readily destroyed. To burn all infected material is a sure but costly safeguard. A simple but sure household method of heat disinfection is to boil any infected article from fifteen to thirty minutes. The various forms of heat are often used in combination with certain chemical disinfectants.

Two of the most commonly used chemical disinfectants are solutions of **carbolic acid** and **corrosive sublimate.** They are both dangerous poisons and must be guarded with the greatest care lest some accident may occur from drinking them by mistake.

QUESTIONS FOR REVIEW

1. What secrets of Mother Nature are revealed by the microscope?
2. Why do many things mold or sour?
3. What are the three simplest forms of plant life?
4. What is yeast?
5. What is mold?
6. What is the common name of the third group?
7. Tell what you can about bacteria.
8. Where are bacteria found?
9. Describe briefly the work done by bacteria.
10. How may bacteria cause disease?
11. How may the germs of disease be carried?
12. In what ways may bacteria gain entrance into the body?
13. How may bacteria be carried in dust?
14. Show how the germs of consumption and diphtheria may be carried in dust.
15. Show how our bodies may defend themselves against the germs of disease.
16. What two powerful helps in preventing the spread of disease are provided by Nature?
17. Describe the outbreaks of pestilence in olden times.
18. How is the health of the people protected in our times?
19. What three things do people now realize are of great importance in combating the ravages of disease?
20. What is meant by vaccination?
21. What is now the chief protection against the ravages of diphtheria?
22. How may isolation serve as a safeguard against diphtheria?
23. What is meant by disinfection?
24. Tell the difference between disinfectants, antiseptics, and deodorants.
25. What are some of the more common disinfectants?

CHAPTER XV

HELP AT HAND; OR WHAT TO DO FOR SIMPLE AILMENTS AND IN ACCIDENTS AND EMERGENCIES

310. What to do for Fainting. — A person who faints should be laid flat on the back, with head lower than the feet. Loosen all tight clothing. Let in plenty of fresh air and bathe gently the head and the neck with cold water. Smelling salts held to the nose tend to excite breathing.

311. The Sting of Insects. — If a piece of the sting of a bee, wasp, or hornet remains in the wound, take it out with the fingers or with the point of a sharp knife. The best application is diluted carbolic acid or ammonia water, after which a cloth moistened with sweet oil or vaseline may be applied. If a person stung is far distant from household remedies, soaking the wound in cold water will often afford much relief.

312. Frostbite. — The ears, the toes, the nose, and the fingers are occasionally frostbitten or frozen. Rub the frozen parts with snow or snow water, in a cold room. Do not rub after a burning, tingling sensation is felt.

313. Nosebleed. — Slight nosebleed requires little treatment. Keep the head erect. Raise up the arm on the

bleeding side. Do not blow the nose. The patient should take several deep inspirations, filling the chest fully at each breath. Apply towels wrung out in cold water around the neck and to the upper part of the nose.

314. Toothache. — Use hot applications on the face, as a hot-water rubber bag or hot flatiron. If the cavity is large enough wind a bit of absorbent cotton around the end of a wooden toothpick or the sharpened end of a lead pencil. Moisten the pledget with creosote or oil of cloves. Plug the cavity with the moistened cotton, crowding above it a pledget of dry cotton. Care must be used not to wet the gums or lips with creosote or to use these remedies carelessly.

315. Chapped Hands. — Protect the hands from cold winds and dry them carefully after washing. Avoid, if possible, using the hands in very hot or very cold water, and then exposing them to bitter cold winds. Glycerin, diluted with rose water and well rubbed in at bedtime, affords much relief. If there are cracks in the skin rub in zinc ointment. Gloves worn at night often do much good.

316. Fomentations. — Flannel is sometimes wrung out of hot water and applied to a painful place. This is called a **fomentation.** Dip the flannel, folded several times into the desired shape, into boiling water; put it into a towel to protect the hands, and wring it. Apply it hot as possible, cover it carefully with larger pieces

of flannel (oiled silk or strips of rubber sheeting are best of all), and use duplicate pieces to make the changes rapidly.

317. Poultices. — Poultices made in the proper way, and applied to the right spot, will give a great deal of relief from sudden and severe pains in the chest, abdomen, and elsewhere. Poultices may be made of flaxseed, oatmeal, rye meal, ground slippery elm, or stale bread.

Stir the meal slowly into a bowl of boiling water, just as the old-fashioned "hasty pudding" or mush is made, until a thin and smooth dough is formed. Fold a piece of old linen or thin cotton cloth of the right size in the middle; spread the dough evenly, about half an inch thick, on one half of the cloth, and cover it with the other.

The secret of using a poultice is to apply it hot, and to have a fresh one ready to take its place as soon as it cools.

318. How to make a Mustard Poultice. —The most common substance used in household poultices is mustard. To make a "mustard paste," as it is called, mix one even tablespoonful of mustard and three or four of flour or meal with enough water or vinegar to make the mixture an even paste. Spread it neatly with a table knife on a piece of old linen, or even cotton cloth, of the required size. Cover the face of the paste with a thin piece of old muslin or linen. Now apply the plaster with its face down.

THE CARE OF THE SICK ROOM

319. Arrangement of the Sick Room. — The **sick room** should have plenty of sunshine, pure fresh air, and freedom from noise and unpleasant odors.

FIG. 136. — A Nurse for the Sick Room

Heavy curtains and other furniture that shut out the sunlight and air should be removed.

Rocking chairs should have no place in the sick room, as their motion is apt to make the patient nervous and irritable.

A small table should stand at the bedside, upon which may be put the food tray, a bell, and some simple ornament.

A cot bed should be provided for the use of the person who attends the patient at night. It should be folded and taken out of the room in the daytime.

Instead of a woolen carpet have a bare floor, with a few rugs and strips of carpet on it to deaden the footsteps.

Windows that rattle, blinds that slam, and doors that creak are always annoying to sick people.

320. Helps for the Sick Room. — The untimely call of some talkative visitor has often cheated a sick person out

of a night's much-needed rest. Ask the doctor for orders about the admittance of visitors and obey them to the letter.

Avoid all talk in the sick room of the patient's symptoms, his chances for recovery, the lack of appetite, the loss of flesh and strength, and other personal matters which have an important bearing upon the welfare of the sick person.

Do not lean upon, sit upon, or jar the sick bed. The bed should be kept solely for the patient.

Do not whisper in or about the sick room. Speak aloud, but in a low, gentle voice. Those who attend the sick should answer the questions of the patient plainly and without hesitation.

321. Hints on nursing Infectious and Contagious Diseases.—The children who have not been attacked should be sent, if possible, to houses where there are no children. Call or notify the doctor, that a card of warning may be placed upon the house. Remove from the sick room all carpets, rugs, curtains, and stuffed furniture.

Take great pains in regard to cleanliness. Boil frequently the dishes and all utensils used in the sick room. Soiled clothing should never be put into the family wash, but put to soak at once in disinfectants. So far as convenient, use only such old and worn clothing about the bed or on the person of the patient as may be burned. The discharges from the bowels and kidneys should

never be allowed to remain in the sick room, but should be removed at once, and all vessels thoroughly washed in hot disinfectants.

ACCIDENTS AND EMERGENCIES

322. First Aid in Accidents and Emergencies. — Can a boy or girl learn how to give first aid in the more common accidents and emergencies that are liable to happen any time? Certainly. With a little pains every young person can become familiar with a few of the simplest helps, and also learn how to apply them.

Besides learning how to keep ourselves well and strong, we should learn how to help those around us who happen to suffer from some accident or have need of our services in sickness.

323. The First Thing to be done. — Accidents and sickness are so common that we hardly need to be told of those sudden dangers which so often give us a chance to lend a hand; as, for example, a child may accidentally swallow some poison, or set his clothing on fire; a boy may fall and break his arm, or may be taken out of the river apparently drowned; a member of the family may be suddenly ill with some contagious disease, or may be nearly suffocated with coal gas.

All these and similar emergencies call for a cool head and a steady hand. It will give us a certain amount of

self-confidence and self-control if we know what to do. Whatever we do must be done promptly, but not with haste.

324. Fits or Convulsions. — A sufferer from **convulsions** or "fits" foams at the mouth, rolls up his eyes, and often bites his tongue or lips.

See that the patient does not injure himself; crowd a folded handkerchief between the teeth, to prevent biting the lips or the tongue. Unfasten the clothing about the neck and chest.

325. Foreign Bodies in the Nose. — Marbles, beans, peas, fruit stones, buttons, and other small objects are sometimes pushed into the nose by children. Try to get the child to help by blowing the nose hard. A sharp blow between the shoulders will often cause the substance to fall out. Stop the well nostril and direct the patient to blow suddenly and forcibly through the other nostril.

326. Foreign Bodies in the Ear. — If the substance is one that will not swell, syringe in a little warm water. This will often wash out the substance. If an insect crawls into the ear, drop in a little sweet oil or molasses. If the top of the outer ear is pulled up gently, the liquid will flow in more readily.

327. Foreign Bodies in the Throat. — Bits of food and other small objects that sometimes lodge in the throat are usually readily removed by the forefinger, or by sharp slaps on the back.

If there are sudden fits of coughing, with a dusky hue and a look of distress about the face, medical help must be called at once.

Coins, pencils, keys, fruit stones, and other small objects are sometimes swallowed. It is safer to give plenty of hard-boiled eggs, cheese, potatoes, and butter crackers, and allow the substance to pass off in the natural way than to give some active laxative.

FIG. 137.—Showing how the Upper Eyelid may be turned back with the Help of a Penholder

(From a photograph taken in the schoolroom)

328. Foreign Bodies in the Eye. — Do not rub the eye, as it will only make a bad matter worse. Often the tears will wash the substance away. It may sometimes be removed with the twisted corner of a handkerchief.

If the offending substance cannot be removed, the upper lid may be turned back.

The upper eyelid may be everted, or turned back, as follows: Seize the lashes between the thumb and forefinger and gently draw the edge of the lid away from the eyeball. Now, telling the patient to look down, press a slender lead pencil or penholder against the lid, parallel to and above the edge, and then pull the edge up and

turn it over the pencil by means of the lashes. The eye is now readily examined, and usually the foreign body may be seen and easily removed with the corner of a pocket handkerchief. After the substance has been removed bathe the eye with hot water until the pain stops.

329. Suffocation. — What is known as **asphyxia**, or **suffocation**, usually results from poisonous gases from the fumes of burning coal in the furnace or stove; from illuminating gas blown out by a draught; from the foul air often found in old wells; from the fumes of charcoal; and from the foul air of mines.

The first thing to do is to give fresh air. Remove the person to the open air and place him on his back. Loosen all tight clothing about the chest and neck and apply cold water. Rub the limbs vigorously. If the breathing is feeble send for medical help. Meanwhile, artificial respiration may be tried, as described in Section 338.

330. Sunstroke and Heatstroke. —There is sudden loss of consciousness in **sunstroke**, with deep, labored breathing, an intense, burning heat of the skin, and a marked absence of sweat.

The first thing to do is to lower the temperature. Strip off the clothing to the waist. Apply chopped ice wrapped in flannel to the head and back of the neck. Rub ice over the chest, and place pieces under the armpits and at the sides. If there is no ice, use cloths wrung

out in cold water. Persons who have once suffered from sunstroke should avoid any risk afterwards.

331. Burns and Scalds.—In **burns** and **scalds** do not pull off the clothing suddenly, but cut and coax it away from the burnt places with sharp scissors. Do not break the blisters, but save the skin unbroken if possible.

Avoid chafing, and keep out the air. Baking soda, used dry or dissolved in water, is a good household remedy for burns. Another remedy often used is the application of strips of old linen soaked in a mixture of half linseed oil and half limewater (carron oil).

Spread freely plain vaseline or carbolized vaseline on strips of old linen with a table knife. Apply to the burnt parts, and protect them from the air with bandages, lint, or wads of absorbent cotton. If the burn is deep or extensive, secure medical help at once.

332. Bruises, Cuts, and Torn Wounds. — A bruise is an injury of the soft parts, caused by a blow of some blunt instrument or by a fall. A "black" eye, black-and-blue spots on the legs, a finger hurt by a baseball, a sprain of the knee or ankle in playing football, are familiar accidents on the athletic field. Bathe the injured parts in hot water to reduce the inflammation and relieve the pain. If the cuts are small, clean the parts, bring the edges together, and stick them with plaster.

When wounds have ragged edges, such as those caused by broken glass, splinters, toy pistols, or rusty nails, more

skill is called for. Such wounds often lead to serious results from blood poisoning. The services of a doctor are usually necessary.

333. The Difference between Bleeding from an Artery and Bleeding from a Vein. — It is always an important matter to know the difference between bleeding from an **artery** and bleeding from a **vein.**

If an artery bleeds, the blood is of a **bright scarlet color**, and **spurts** in a stream. If a vein bleeds, the blood is of a somewhat **darker color**, and slowly **oozes out**, or **flows in a steady stream.**

FIG. 138. — Showing how an Improvised Apparatus may be used to check Bleeding from an Artery in the Arm

This apparatus consists of half of a potato held in place over the artery by a pocket handkerchief used as a band. A stick, picked up on the ground, is inserted beneath the band on the opposite side of the limb, and used as a lever to press the potato firmly against the artery

Bleeding from an artery may be dangerous, and life itself may be speedily lost if the artery is large. Bleeding from a vein, on the other hand, is rarely a serious injury, and usually stops of itself, although the bleeding may be relieved, if need be, by pressure.

334. What to do for Arterial Bleeding. — In all cases of arterial bleeding **remember to make deep pressure between the wound and the heart.** Send at once for the doctor.

Meanwhile there is something to do. Keep cool, and do not be afraid to act at once. A firm grip with the fingers in the right place will do until a twisted handkerchief, stout cord, shoestring, or suspender is ready to take its place. Make a knot in whatever is used, and bring the pressure of the knot to bear over the artery. If the flow of blood does not stop, change the pressure until the right spot is found and the bleeding ceases.

FIG. 139. — Showing how Firm Pressure may be made with the Fingers to compress the Brachial Artery of the Left Arm. Some Large Superficial Veins are also shown

335. How to apply Pressure. — It is important to know the principal places where pressure is to be applied when arteries are injured and bleeding.

If the wound is in a **finger**, grasp it with the thumb and forefinger, and pinch it firmly on each side; if in the hand, press with the thumb just above and in front of the wrist.

For injuries **below the elbow**, grasp the upper part of the forearm with the hands and squeeze hard.

For the **upper arm**, press with the fingers against the inner edge of the biceps muscle.

For the **foot** or **leg**, press in the hollow behind the knee, just above the calf of the leg.

336. Broken Bones. — Send for a surgeon at once. Loss of power, pain, and swelling are symptoms of a **broken bone** that are usually easily recognized.

FIG. 140. — Showing how an Improvised Apparatus may be used for a Broken Radius

This temporary dressing consists of two pieces of oak bark for splints, with grass for padding, and is secured in place by a boy's long stocking and a pocket handkerchief

Broken limbs should always be handled with great care. If the accident happens at a distance from immediate help, the limb should be bound with handkerchiefs, suspenders, or strips of clothing to a piece of board, pasteboard, or bark, padded with moss or grass. Always put a broken arm into some kind of sling after the temporary splints are put on.

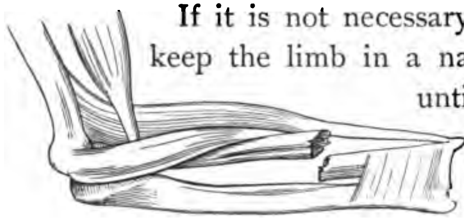

FIG. 141. — A Broken Radius

If it is not necessary to move the patient, keep the limb in a natural, restful position until the doctor comes.

If the injured person must be moved, do not do so until the limb is made safe from further injuries by putting on some kind of support or splint.

337. What to do in Apparent Drowning. — Remove all tight clothing from the neck, chest, and waist.

FIG. 142. — A Broken Collar Bone

Turn the body on the face, raising it a little with the hand under the hips, to allow any water to run out from the air passages.

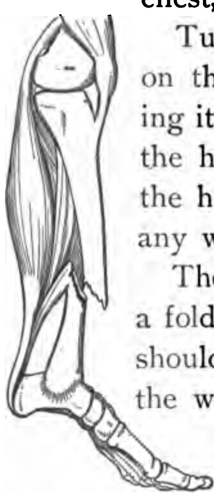

FIG. 143. — A Broken Shin Bone, or Tibia

Then lay the person flat upon the back, with a folded coat, or pad of any kind, under the shoulders, to raise them a little. Remove all the wet, clinging clothing that is convenient.

If in a room or sheltered place, strip the body and wrap it in blankets, overcoats, etc. Use bottles of hot water, hot flatirons, or hot sand round

the limbs and feet. The main thing to do in apparent drowning, or in other cases of suspended animation, is to keep up **artificial respiration** until the natural breathing comes, or till all hope is lost.

338. How to produce Artificial Respiration.—The patient is laid on the back. Let some one kneel behind the head and grasp both arms near the elbows, sweeping

FIG. 144. — Production of Artificial Respiration. (First Movement — Inspiration)

them upward above the head until they nearly touch. Make a firm pull for a moment. This tends to fill the lungs with air by drawing the ribs up and making the chest cavity larger.

Now return the arms to the sides of the body until they press hard against the ribs. This tends to force out the air. Repeat this act about fifteen times every minute. All this may be continued for several hours.

FIG. 145.—Production of Artificial Respiration.
(Second Movement—Expiration)

When a person can breathe, even a little, he can swallow. Then give a few teaspoonfuls of hot, strong coffee or hot ginger tea every few minutes.

339. Accidental Poisoning.—Poisons of various kinds are often kept about the house, stable, bathrooms, and workshops as medicines, as disinfectants, for killing insects and animals, and for many other purposes.

People are often careless in leaving poisons in the cupboard, or on a shelf, wrapped in a piece of paper, or in some unlabeled bottle. Children either mistake them, or are urged by some playmate to swallow them.

340. Safeguards against Poisoning. — Poisons should always be carefully labeled, and the word POISON plainly printed in large letters across the label.

Fasten the cork firmly to the bottle by copper wire twisted into a knot at the top. This or some other simple plan would serve to prevent a person in the dark from mistaking liquid poisons for medicine.

Poisons should never be kept in the same place with medicines or other bottled preparations used in the household. Put them in some secure place, and under lock and key.

Here is a golden rule: Never use the contents of any package or bottle unless you know exactly what it is.

341. What to do in Poisoning. — Poisons may be taken when it is hard to procure medical help. In such case something must be done at once and in earnest, as they do their work rapidly.

The stomach must be emptied as speedily as possible. Make a quart of warm soapsuds, and force the sufferer to gulp it down, a cupful at a time.

A good emetic is made by putting a tablespoonful of ground mustard into a quart of warm water. Drink a cupful every ten minutes until vomiting is produced.

QUESTIONS FOR REVIEW

1. What would you do for fainting?
2. What is good treatment for the sting of insects?
3. How would you treat frostbite?
4. What would you do for nosebleed?
5. What can you say about some remedies for toothache?
6. How would you treat chapped hands?
7. How would you prepare fomentations?
8. What are poultices, and what are they used for?
9. How would you make a mustard poultice?
10. What hints can you give about the care of a sick room?
11. With what other helps for the sick room are you familiar?
12. What practical hints can you give on nursing infectious and contagious diseases?
13. How can a boy or girl learn to be of service in accidents and emergencies?
14. Describe the treatment for fits or convulsions.
15. What is the treatment for foreign bodies in the nose? In the ear? In the throat? In the eye?
16. Describe the treatment for sunstroke.
17. What should be done for burns and scalds?
18. Describe a simple treatment for bruises and cuts.
19. How may you know the difference between bleeding from an artery and bleeding from a vein?
20. What is the chief thing to be done for arterial bleeding?
21. Where and how would you apply pressure in bleeding from arteries?
22. What would you do for broken bones?
23. What is to be done in apparent drowning?
24. Describe the process of producing artificial respiration.
25. What are some common safeguards against poisoning?
26. What are the important things to do in case of poisoning?

NOTES

Chapter III, Page 31

THE MUSCLES

1. The influence of alcohol upon muscular work has been established experimentally; it has been demonstrated that man works better when he does not use this pretended stimulant. . . . The physiological experiments of Destrée have established that alcohol is a paralyzer of muscular work. — Dr. J. de Vaucleroy, Professor of Hygiene in the Military School of Belgium.

2. Every penny which the workman spends for alcoholic drinks is not only wasted but employed for a destructive purpose. The workman would use the money expended for alcohol to the best advantage if he purchased fatty foods and sugar instead. — Adolf Fick, late Professor of Physiology, University of Würzburg.

3. *The Cyclists' Route Book* is explicit enough: "Alcoholic drinks should be avoided; they prevent good work being done." — Dr. Andrew Baxter in *Scottish League Journal.*

4. On January 4, 1891, Davis Dalton accomplished the feat of swimming twelve hours on his back without using his arms or leaving the water. He attributed his successful endurance to abstinence from alcohol. "No man," he said, "who took a drink could possibly perform the feat." — Dr. Andrew Baxter in *Scottish League Journal.*

5. It is the same in cold countries and in temperate regions. Most arctic explorers reject the use of alcohol. . . . Mountain guides, balloonists, bicyclists, so numerous nowadays, and athletes in general recognize the bad effect of alcohol on the muscular energy developed. — E. Destrée, Professor in the University of Brussels.

6. A six days' bicycle race, which took place in December, 1898, in New York, has proved once more the superior endurance of total abstainers.

The winner, Charles W. Miller of Chicago, rode more than 2000 miles from midnight, December 4, to midnight of December 10. He finished the race without sustaining perceptible bodily injury; he was sound physically and mentally, and needed only a little food and sleep for complete restoration.

At the beginning of the race he had thirty-three competitors, but from the beginning it was seen that the game was to be played by four men, C. W. Miller, F. Waller, B. W. Pierce, and F. Albert. Miller, who made 2007 miles, is a total abstainer. Waller covered 1985 miles; he took no alcoholic drinks during this racing. Pierce accomplished 1906 miles; he drinks a little; once he took a spoonful of brandy. Albert, who made 1822 miles, took a glass now and then, and drank a little beer during the race. The opinion of racers is that any habitual drinker could not have endured this terrible contest. — *L'Abstinence.*

7. A healthy man, with well-aërated blood, taking good nourishing food, and giving every part of his body a certain amount of rest, is able to accomplish a definite amount of work, the maximum being attained when the work can be done at regular intervals, and in a definite period. No amount of alcohol, however given, can increase the amount of work done in that same period without giving rise to very serious disturbances in some part or other of the body; indeed, the amount of work is never increased, as any temporary excitement is invariably followed by depression of such nature that the increase of work supposed to be done during the period of excitation is far more than counterbalanced by the diminution in the amount of work done during the period of depression. — G. SIMS WOODHEAD, M.D., Professor of Pathology, Cambridge University, England.

8. The idea that tobacco gives increased power to endure either physical or mental hardships is one of the greatest delusions of the age. Tobacco and alcohol, though unlike in many respects, have

many points of resemblance, and arguments against one are usually valid against the other. Both are poisons, and both are regarded by many as necessities. It was formerly thought that alcohol augmented strength, but it has been found by experiments that the man who drinks it cannot lift so heavy a weight as those who do not, though he feels as if he could lift a much heavier one. Tobacco may for a short time make a man less conscious of his fatigue; but the truth is that his strength is diminished rather than increased by its use. — THOMAS G. ROBERTS, M.D.

CHAPTER VI, PAGE 74

ORIGIN AND NATURE OF FERMENTED DRINKS

9. As regards the use of alcohol in small doses and alcohol in any form, I may simply reply that a poison is a poison, no matter how it is taken. Mercury is mercury, no matter in what form we give it. — ALBERT E. STERNE, M.D., Professor of Nervous and Mental Diseases, College of Physicians and Surgeons, Indianapolis, in *Journal of the American Medical Association.*

10. The limited advantage claimed in favor of the food value of alcohol is now further reduced and even made nil by the fact that alcohol appears to be a more or less dangerous poison for the human animal body, and that all its supposed blessings must be purchased at an extraordinarily high price. — PROFESSOR T. LAITINEN in *Zeitschrift für Hygiene.*

11. There is no escape from the fact that alcohol is a poison, especially to the nervous system, one whose effects naturally will vary with the amounts and the frequency with which it is used and the stability of the structure upon which its influence is exerted. — *Philadelphia Medical Journal.*

12. This association should continue to urge the necessity of further legislation to check the ravages of that *seductive but destructive* poison [alcohol]. — R. PERCY SMITH, M.D., in a lecture before the British Medical Association, August 1, 1900.

13. All the alcohols are dangerous poisons. — M. MAGMAN, in a discussion before the French Academy of Sciences, July 30, 1895.

14. We all acknowledge that alcohol is a poison and alcoholism is a scourge. — M. DARENBURG, Secretary of the French Academy of Sciences.

15. Alcohol is always a poison. — M. J. ROCHARD, Member of the French Academy of Sciences.

16. Alcohol is a very dangerous poison; its constantly increasing use, particularly in its worst form, whisky, is so terrible an economic, moral, and sanitary evil that all means calculated to check its use in the least are to be greeted with joy. — PROFESSOR MAX GRUBER, President of Royal Institute of Hygiene, Munich.

17. In consequence of the widespread use of alcoholic liquors as beverages, baleful effects of this poison are not confined to individuals. They affect and are felt by whole communities. Absolute alcohol under all circumstances, even in small quantities, produces symptoms of poisoning. — ZIEMSSEN'S *Cyclopædia of the Practice of Medicine*.

18. Alcohol must be regarded as a poison. — International Manifesto signed by more than eight hundred physicians in ten different countries in Europe and America.

19. Alcohol is certainly not a food but a slow poison to all who habitually use it, causing not "a short life and a merry one," as some would say, but a short life and a sickly life. — CHARLES R. DRYSDALE, M.D., Consulting Physician, Metropolitan Hospital, London, England.

20. Alcohol is a poison, and the cause of a huge death-rate. I do not think this will be disputed. It has been proved too often and too thoroughly and completely by common experience. . . . Alcohol poisons most those who drink most. — DR. ARCHDALL REID, Edinburgh, Scotland.

21. There is not the least doubt that alcohol is a poison. — PROFESSOR WAGNER VON JAUREGG, University of Vienna.

22. Let a man drink much beer, enough to make the amount of nourishment in it of value, and the other influences produced by

such a quantity will become manifest to such a degree as to cast the factor of nourishment into the background. If he drinks little beer, the food value is not appreciable. — J. ROSENTHAL, M.D., Professor of Physiology and Hygiene in Erlangen.

23. Drunkenness is seizing with a terrible grip the working population of Belgium. Belgium is only surpassed by Bavaria in the consumption of beer, two hundred and forty litres a year being credited to each inhabitant. — *The London Lancet*, 1888.

24. From the physician's standpoint nothing is more false than the belief that the progressive dislodgment of other alcoholic drinks by beer will diminish the destructive influence of alcoholism. — PROFESSOR G. VON BUNGE, in *Die Alkoholfrage.*

25. Any increased consumption of beer, however good for the brewers and the national exchequer, will not conduce to sobriety or to a diminution of the disease and misery produced by alcoholism. — *The London Lancet*, 1899.

26. Beer cannot be used as a weapon against spirits. An increase of the use of beer does not cause a diminution in the use of spirits. It is not true that beer is less harmful than spirits. For the people as a whole quite the contrary is true. . . . The whole question whether beer can be used in the war against spirits has, therefore, not only been settled long ago to the disfavor of beer, but it is to-day senseless and dangerous, since it veils the real danger which threatens us and conceals the abyss before which we stand. — H. BLOCHER, M.D., Basle, Switzerland.

27. Dr. Smith, of Schloss Marbach, in a paper read before the Society of German Naturalists and Physicians, at Vienna, a few years ago, severely criticised the drinking habits of the Germans, which have invaded all ranks of society, and which he believes are causing a deterioration of the German nation, which will ultimately put them at a decided disadvantage in comparison with temperate nations. — J. H. KELLOGG, M.D., 1896.

Chapter VII, Page 87

DIGESTION, AND HOW IT GOES ON

28. It is commonly thought that alcoholic drinks act as aids to digestion. In reality it would appear that the contrary is the case. . . . The inhibitory influence of alcohol on digestion has been observed on a patient with a gastric fistula, on several other persons by the aid of the stomach pump, and by means of numerous other experiments. — Professor G. von Bunge, Basle, Switzerland.

29. No experiments on alcohol and its influence on digestion (Chittenden and Mendel, for instance) have ever disclosed any beneficial effect of it. — Dr. P. A. Levene, New York.

30. Nearly the whole of the alcohol consumed is absorbed by the capillaries of the stomach and carried in the blood to the liver, where it is in consequence more concentrated than when it has passed through other parts of the body; therefore we find that its effects on the liver are more marked than on other organs, and we get cirrhosis, enlargement, and fatty degeneration of that organ as the result of direct interference with the liver cells and the peculiar action of alcohol on the connective tissue, which it transforms from a permeable tissue into a dense, more or less impermeable tough structure resembling parchment. — Surgeon-Major G. F. Poynder.

31. We generally find cirrhosis is due to alcohol. Cirrhosis of the liver is commonly spoken of as gin-drinker's liver. And it has been established that a number of cases even in children were really due to alcoholism. — Jacobi's *Clinical Lectures on Pediatrics*.

Chapter VIII, Page 111

THE BLOOD AND ITS CIRCULATION

32. Of these indirect effects (of alcohol) none is more often observed than a quickening or slowing in the pulse rate, as is frequently seen in medical practice. These indirect influences must

not be allowed to hide the true character of alcohol, which is always depressant in kind, and which easily gets the upper hand of the effects just noted. In a word, alcohol, in respect to its inherent action, when once in the blood and tissues, must be classed with the anæsthetics and narcotics. — PROFESSOR J. J. ABEL of Johns Hopkins University.

33. Fatty degeneration of the endothelial cells and sometimes of the smooth muscle is found with sufficient frequency in the blood vessels of different organs to be ascribed to the effect of the alcohol. — PROFESSOR W. H. WELCH of Johns Hopkins University.

34. A man is as old as his arteries. If a man is forty years of age, and his arteries are as if he were eighty years of age, the man is that age, as far as his chances of life are concerned. Alcohol is only one of the causes of this hardening, I admit, but it is an important one. — PROFESSOR G. SIMS WOODHEAD, Cambridge University, England.

35. More serious [than the effects of alcohol upon the liver] is the excessive deposit of fat in the muscle-substance of the heart, a condition that is called fatty heart. When the heart is thus infiltrated with fat, and in place of effective muscle-substance contains this inert, in a certain sense, dead mass, there is as a natural result a considerable lowering of the working ability of the heart, which, like a pump, has to drive the nourishing blood to all the body organs. Therefore the blood gradually becomes sluggish in the different organs, namely, in the respiratory, digestive, and nervous systems. Such persons have an irregular, weak heart-beat, a chronic laryngeal and bronchial catarrh develops, and digestion becomes constantly poorer and slower; there are also brain and nerve derangements, due not only to the stagnation of the blood, but also to the direct action of alcohol upon the nerve cells. — DR. WEICHSELBAUM, Vienna.

36. The injurious effects of tobacco on the heart are well known. It is a common experience for the physician, in examining candidates for life insurance, to come unexpectedly, in an otherwise apparently

healthy person, upon the peculiar nervous pulse and quick, jerky heart-beat, rapidly mounting up under the slight exertion or excitement of the examination to 100 or 120 beats per minute, sometimes intermitting, and sometimes presenting a slight valvular murmur, which denotes an excessive user of the weed, and which is known as "tobacco heart." In its slighter degrees a cure is readily effected by abstinence from tobacco. — J. M. French, M.D., Milford, Mass.

Chapter IX, Page 131

WHY AND HOW WE BREATHE

37. Alcoholism makes the bed of tuberculosis. — Dr. Landouzy, of the French Academy of Medicine.

38. The use of alcohol renders the human system susceptible to tuberculosis, and prevents recovery from the same. Alcoholism increases the bad effects of those diseases from which tuberculosis most easily develops. — Dr. Legrain of Paris.

39. Catarrh of the pharynx, larynx, and bronchi is common in alcoholic patients. — Professor W. H. Welch of Johns Hopkins University.

Chapter XII, Page 176

THE NERVOUS SYSTEM

40. Men say and do after a single glass of strong drink what they would not say or do without it, and therefore it clearly affects the brain and diminishes self-control. — Professor G. Sims Woodhead, Cambridge University, England.

41. There is good testimony, not yet controverted or even contradicted, that comparatively small doses of alcohol have a direct deleterious action on the nervous functions and the capacity for work. —*Journal of the American Medical Association.*

42. A German scientist has carefully watched the effect of two glasses of whisky a day on a man's ability to do mental work, and

has detected striking results. He tested a strong man, who was a total abstainer, as to the amount of intellectual effort he could put forth with and without alcohol. . . . The effect of one dose — i.e. two glasses — lasted ten hours. Its continued use day after day decreased still more the ability to do good work. If the dose were increased to three glasses a day, in five days the power of the brain was diminished enormously. If the use of alcohol was discontinued and the brain allowed to get rid of the poison, the intellectual power began to rise, and by and by it would reach its normal limit. A repetition of the experiment proved that the result from the alcohol [then] came much more readily than at first, showing that the brain had received an actual injury. Even if seven days were allowed to elapse before the experiment was repeated, one dose brought a return of all the symptoms.— T. S. CLOUSTON, M.D., Edinburgh, Scotland.

43. The brutality of many of the acts which occupy the time of our coroners and our law courts is becoming serious. . . . Every day's newspaper reports some deed which is simply brutal in its coarseness and its carelessness. . . . The invariable element in all such brutal acts is alcohol. — *The London Lancet*, 1898.

44. Disastrous as is the use of alcohol to our physical well-being, the evil wrought by it here is as nothing to the moral and intellectual degradation brought about in minds and characters of which the original possibilities were of the very highest order. — PROFESSOR G. SIMS WOODHEAD, Cambridge University, England.

45. Alcohol diminishes the keenness of the moral sense ; it blunts the acuity of discrimination between right and wrong, and it impairs the will power, the power to do right, and easily leads its victims into a vicious life. — DANIEL R. BROWER, M.D., LL.D., Chicago, Ill.

46. In France it has been found that insanity has increased with the increase of drunkenness. — C. W. CHANCELLOR, U. S. Consul to Havre, France.

47. I do not advise you, young men, to consecrate the flower of your life to painting the bowl of a pipe, for, let me assure you, the stain of a reverie-breeding narcotic may strike deeper than you

think. I have seen the green leaf of early promise grow brown before its time under such nicotian regimen, and thought the ambered meerschaum was dearly bought at the cost of a brain enfeebled and a will enslaved. — OLIVER WENDELL HOLMES.

48. Tobacco destroys the bodies and stupefies the minds of nations. It is the undoubted adversary of intelligence. — ALEXANDRE DUMAS.

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THE FIVE GATEWAYS OF KNOWLEDGE

49. Careful observers have noted, before and after the use of alcohol, the condition of the senses, and in all cases a diminution in acuteness and activity was observed. While a man may believe that his senses are keener and his powers of endurance greater, careful experiments with instruments of precision have shown that his hearing is reduced, his acuity of vision is lowered, his taste obtunded, his sense of smell blunted. — A. D. MCCONACHIE, M.D., Baltimore, Md.

50. Professor Abel, of Johns Hopkins University, thus reports experiments made to test the effect of alcohol upon the ability to measure distance with the eye. The investigator used an apparatus which "consisted of a strip of wood exactly one meter in length, whose divisions were marked on the opposite side of the observer. An assistant moved a sliding marker until the subject of the experiment believed that the pointer had reached the middle point of the strip. Equal illumination of the two halves of the bar and good light for the observer were among the many precautions. Ten readings were taken during each trial, and the pointer was started alternately from the right and left ends of the bar." The average error in the eye measurement without alcohol was 0.19 cm.; with alcohol it was 0.44 cm. Alcohol increased the error .25 cm.

51. The subjects who usually suffer with tobacco blindness are almost always males between the ages of 30 and 60 years. Exceptions

to this occasionally occur, and in my own series of examinations I found one man aged 19 who presented a well-marked case of this trouble. He was a most inveterate chewer and smoker of tobacco. . . . These patients see better in the evening than in the middle of the day. . . . They often complain of a glimmering mist which covers all objects, especially in a bright light. — *Journal of the American Medical Association*, 1900.

52. That tobacco contains some substance injurious to the eyes has been well proved by an outbreak of blindness among horses in a district in Australia where a kind of wild tobacco plant began growing in the pastures soon after a local flood. The horses in other respects were well. The blindness came on very gradually, taking sometimes two years, and was confined to the districts where the tobacco plant grew.

53. Not long since a large railroad corporation investigated the conditions surrounding every accident that had occurred on its lines during the preceding five years. It was found that forty per cent of all accidents were due entirely or in part to drinking men. In eighteen per cent it was strongly suspected that the drinking habit among employees was the cause of accidents. The company lost property to the amount of one million dollars in a single year through the incompetence of beer-drinking engineers and switchmen.

54. Michigan has passed a law which imposes a heavy penalty upon those railroad companies who employ men who are in the habit of using alcoholic intoxicants. Railroad managers, as practical business men, are recognizing the utility of employing total abstainers as a measure calculated to reduce financial losses on account of accidents. — J. W. GROSVENOR, M.D., in *Journal of the American Medical Association*, 1896.

GLOSSARY OF TECHNICAL TERMS

Many words that are defined or explained as they occur in the text of this book, or the meaning of which is readily understood, have been omitted.

Ab-do'men. The largest cavity of the body, containing the liver, the stomach, the intestines, and other organs.

Ab-sorp'tion. The process of sucking up nutritive or waste matters by the blood vessels or lymphatics.

Al-bu'men. Formerly used as a synonym for proteid.

Al-bu'min. A class of proteids, as egg albumin.

Al'i-men'ta-ry. Pertaining to aliment, or food.

Al'i-men'ta-ry ca-nal'. The digestive tube from the lips to the end of the rectum, with its accessory glands.

Al'ka-lies. Certain substances, such as soda, potash, and the like, which unite with acids to form salts.

A-mœ'ba. A single-celled, protoplasmic animal, which has the power of changing its form by protrusions and withdrawals of its substance.

A-mœ'boid. Like an amœba in form or in movement.

An'æs-thet'ic. A substance which produces insensibility to pain or to touch, as chloroform, ether, etc.

An'ti-dote. A substance given to prevent or counteract the action of a poison.

An'ti-sep'tic. A remedy or agent which prevents the development of bacteria, or prevents the growth of bacteria upon which putrefaction depends.

An'ti-tox'in. A substance which neutralizes the action of the toxins of bacteria. Antitoxins are used in the treatment of certain infectious diseases, as diphtheria.

Ap'pa-ra'tus. Used to designate collectively organs which perform a certain function.

As-phyx'i-a. Suffocation. The suspension of vital phenomena when the lungs are deprived of oxygen.

As-sim'i-la'tion. The conversion of food into living tissue.

Ba-cil'lus. A microscopic rod-shaped form of bacteria.

Bac-te'ri-cide. An agent that destroys bacteria.

Bac-te'ri-um, pl. **bac-te'ri-a.** A microscopic vegetable organism.

Cap'il-la-ry. A minute vessel, as those that connect by a network the arteries and veins.

Car'bon di-ox'ide. A gas produced in the respiration of animals, and in the

decay or combustion of organic matter. Often called carbonic acid gas.

Car'di-ac or'i-fice. The orifice of the stomach, near the heart.

Car'ron oil (from its first use at the Carron Iron Works in Scotland). A mixture of equal parts of linseed oil and limewater.

Car'ti-lage. Gristle. A tough but flexible tissue forming a part of the joints, air passages, nose, ears, etc.

Ca'se-in. A proteid substance found especially in milk. The principal ingredient in cheese.

Cell. One of the ultimate units of which all living bodies are composed. A mass of protoplasm containing a nucleus.

Chlo'ral. A powerful drug and narcotic poison used to produce sleep.

Chlo'ro-form. A narcotic poison generally used by inhalation; of extensive use in surgical operations to produce anæsthesia.

Cil'i-a. Minute threadlike processes found upon the cells of the air passages and other parts.

Co-ag'u-la'tion. The process by which a liquid like blood or milk clots, or solidifies.

Co'ca-ine. A bitter, white substance obtained from the leaves of coca, capable of producing local insensibility to pain when applied to the surface of mucous membranes or injected under the skin.

Co'ma. A deep stupor from which it is difficult or impossible to arouse a person.

Com'press. A pad or bandage applied directly to an injury.

Con-ges'tion. Abnormal collection of blood in a part or in an organ.

Con'junc-ti'va. A thin layer of mucous membrane which lines the eyelids and covers the front of the eyeball, thus joining the latter to the lids.

Con-ta'gion. The process by which a specific disease is communicated from one person to another, either by contact or by means of an intermediate agent. Also the specific germ, or virus, which causes a communicable disease.

Con'trac-til'i-ty. The property of a muscle which enables it to draw its extremities closer together.

Con'vo-lu'tions. Tortuous foldings, as those of the external surface of the brain.

Co-ör'di-na'tion. The manner in which different organs of the body are made to work together.

Cor'ne-a. The transparent hornlike substance which covers a part of the front of the eyeball.

Cor'pus-cle. A small body or particle.

Crys'tal-line lens. One of the refractive media of the eye; a double-convex body situated in the front part of the eyeball.

Cu'ti-cle. Scarfskin; the epidermis.

Cu'tis. The true skin, also called the dermis.

De-gen'er-a'tion. A morbid process in the structure of an organ by which its tissues are converted into some inert substance.

Deg'lu-ti'tion. The act of swallowing.

Den'tine. The hard substance which forms the greater part of the tooth; ivory.

De-o'dor-ant. A substance which removes or conceals offensive odors.

Dis'in-fect'ants. Agents used to destroy the germs of disease, fermentation, and putrefaction.

Dis'lo-ca'tion. An injury to a joint in which the bones are displaced or forced out of their sockets.

Dis-sec'tion. The cutting up of an animal to learn its structure.

Du'o-de'num. The first division of the small intestines, about twelve fingers' breadth long.

Dys-pep'si-a. The name given to certain diseases of the digestive organs.

El'e-ment. One of the simplest parts of which anything consists.

E-lim'i-na'tion. The act of expelling waste matters. Signifies literally "to throw out of doors."

E-met'ic. An agent which causes vomiting.

E-mul'sion. A preparation consisting of a liquid, usually water, containing an insoluble substance, as fat, in suspension.

E-nam'el. Dense material covering the crown of a tooth.

Ep'i-dem'ic. A disease which affects large numbers, or which spreads over a wide area.

Ep'i-glot'tis. A leaf-shaped lid which covers the top of the larynx during the act of swallowing.

Ep'i-lep'sy. A nervous affection, accompanied by fits and sudden loss of consciousness, often preceded by a peculiar sensation.

E'ther. A narcotic poison. Its chief use is as an anæsthetic in surgical operations.

Eu-sta'chi-an tube. The tube which leads from the throat to the middle ear.

Ex-cre'ta. The refuse matter which is passed from the body in any form.

Ex-cre'tion. The separation from the blood of the waste matters of the body; also the materials excreted.

Fau'ces. The part of the mouth which opens into the pharynx.

Fer'ment. Any substance which in contact with another substance is capable of setting up changes (fermentation) in the latter, without itself undergoing much change.

Fer'men-ta'tion. An effervescent change, as by the action of yeast; in a wider sense, the change of organic substances into new compounds by the action of a ferment. It differs in kind according to the nature of the ferment.

Fi'brin. A proteid substance contained in the flesh of animals, and also produced by the coagulation of blood.

Fol'li-cle. A little pouch or depression, as the hair follicle.

Fo'men-ta'tion. The application of heat and moisture to a part to relieve pain and reduce inflammation.

Fu'mi-ga'tion. Disinfection by means of a vapor.

Func'tion. The normal or special action of a part.

Gel'a-tin. An albuminoid substance which dissolves in hot water and forms a jelly on cooling.

Germ. A portion of matter capable of developing into a living organism, — a microörganism.

Ger'mi-cide. An agent which destroys germs, especially bacteria.

Gland. An organ consisting of one or more follicles and ducts, with numerous blood vessels interwoven.

Glot'tis. The space between the vocal cords.

Hem'i-sphere. Half a sphere; the lateral halves of the cerebrum.

Hem'or-rhage. Bleeding, or the loss of blood.

He-pat'ic. Pertaining to the liver.

Hy'dro-gen. An elementary gaseous substance, which, in combination with oxygen, produces water.

Hy'dro-pho'bi-a. A disease caused by the bite of a rabid dog or other animal.

Im-mune'. Exempt from certain diseases by inoculation, by previous attack, or by nature.

In-ci'sor. Applied to the four front teeth of both jaws, which have sharp, cutting edges.

In'cus. One of the bones of the middle ear.

In'di-an hemp. The common name of *Cannabis indica*, an intoxicating drug known as "hasheesh" and by other names in Eastern countries.

In-fec'tion. The communication of disease from one body to another, or from one part to another part of the same individual (auto-infection). The material conveying the disease; the disease-producing agent.

In-fe'ri-or ve'na ca'va. The vein carrying blood from the lower part of the body into the heart.

In'flam-ma'tion. Tissue changes accompanied with redness or swelling of any part of the body, with heat and pain.

In-oc'u-la'tion. The introduction of the germs of disease, generally through the skin, so as to produce the disease.

I'ris. The thin muscular ring which lies between the cornea and crystalline lens, giving the eye its special color.

Lab'y-rinth. The internal ear, so named from its many windings.

Lach'ry-mal ap'pa-ra'tus. The organs for forming and carrying away the tears.

Lens. A piece of transparent glass or other substance so shaped as either to converge or disperse the rays of light.

Lig'a-ture. A thread of some material used in tying arteries or other parts.

Lobe. A round, projecting part of an organ, as of the liver, lungs, or brain.

Lockjaw, see "Tetanus."

Lymph. The watery fluid in the lymphatic vessels.

Mal'le-us. The mallet; one of the small bones of the middle ear.

Me-dul'la ob-lon-ga'ta. The "oblong marrow," also called the spinal bulb;

that portion of the brain which lies upon a portion of the occipital bone.

Mem-bra'na tym'pa-ni. Literally, "the drum membrane"; the membrane separating the outer from the middle ear.

Mi'crobe. A living organism of very small size, — a microörganism, — either animal or vegetable.

Mol'e-cule. The smallest portion of a substance which can retain the properties of the substance.

Mu'cous mem'brane. The thin layer of tissue which covers those internal cavities or passages which communicate with the external air.

Mu'cus. The thin glairy fluid secreted by mucous membranes.

Nar-cot'ic. A substance that produces stupor, convulsions, and sometimes death.

Nic'o-tine. A poisonous substance found in the leaves of the tobacco plant.

Nu-cle'o-lus. A small body often found within the nucleus of a cell.

Nu'cle-us. An essential part of a typical cell, often spherical and usually found near the center.

Œ-soph'a-gus. The tube leading from the throat to the stomach; the gullet.

Ox-i-da'tion. The union of oxygen with other substances, as in combustion. The essential part of burning and of breathing.

Pal'ate. The roof of the mouth, forming the hard palate, and the curtain at the back of the mouth, called the soft palate.

Pal'pi-ta'tion. A violent and irregular beating of the heart.

Pa-pil'læ. The small elevations found on the skin and mucous membranes.

Pa-ral'y-sis. Loss of function, especially of motion or feeling.

Par'a-site. A plant or animal living upon or within another organism, called the host.

Pel'vis. The bony cavity at the lower part of the trunk.

Pep'sin. A ferment found in the gastric juice, and capable of digesting proteids in the presence of an acid.

Per'i-os'te-um. A delicate membrane which invests and nourishes the bones.

Per'i-to-ne'um. The investing membrane of the stomach, intestines, and other abdominal organs.

Pha-lan'ges. The bones of the fingers and toes.

Phar'ynx. The cavity behind the mouth and the nose, leading to the gullet.

Pin'na. The external cartilaginous flap of the ear.

Plas'ma. The fluid part of the blood and the lymph.

Pleu'ra. A membrane covering the lung and lining the chest.

Plex'us. A network of vessels, nerves, or fibers.

Poi'son. A substance that, when introduced into the body, either destroys life or impairs seriously the function of one or more of its organs.

Por'tal vein. The venous trunk formed by the veins coming from the stomach and the intestines. It carries the blood to the liver.

Proc'ess. Any projection from a surface; also, a method of performance, a procedure.

Pro'te-ids. A general term for the albuminous constituents of the body.

Pro'to-plasm. The viscid material constituting the essential substance of living cells upon which all the vital functions of the body depend.

Pto'ma-ine. One of a class of substances, formed during the decomposition of proteids. See "Toxin."

Pu'pil. The central, round opening in the iris, through which light passes into the interior of the eye.

Pus. A yellowish-white, creamy liquid produced by suppuration.

Py-æ'mi-a. A form of blood poisoning produced by the absorption into the blood of morbid matters usually originating in a wound or local inflammation.

Py-lo'rus. The opening of the stomach at the beginning of the small intestine.

Re'flex. Involuntary movements or secretion produced by an excitation traveling along a sensory nerve to a center, where it is turned back or reflected along motor or secretory nerves.

Res'pi-ra'tion. The act of breathing in and breathing out air.

Ret'i-na. The innermost of the three coats of the eyeball.

Roent'gen rays. See "X-rays."

Scle-rot'ic. The tough, fibrous outer coat of the eyeball.

Se-ba'ceous. Resembling fat; said of the oily secretion by which the skin is kept flexible and soft.

Se-cre'tion. The process of separating from the blood some essential, important fluid, which fluid is also called a secretion.

Sem'i-cir'cu-lar ca-nals'. Canals in the internal ear.

Sep'ti-cæ'mi-a. Blood poisoning; a form of poisoning resulting from the presence in the blood of the products of putrefactive microörganisms.

Se'rum. The clear, watery fluid which separates from the clot of the blood.

Spu'tum, pl. **spu'ta.** Matter which is coughed up from the air passages.

Sta'pes. One of the small bones of the middle ear.

Stim'u-lant. An agent which causes an increase of activity in the body or in any of its parts without increasing its supply of energy.

Styp'tics. Substances that, applied locally, arrest bleeding.

Sub-cla'vi-an vein. A great vein, so called because it is situated underneath the clavicle, or collar bone.

Su-pe'ri-or ve'na ca'va. The great vein of the upper part of the body.

Syn-o'vi-a. The fluid secreted by the synovial membranes, which lubricates the joints; joint oil. It resembles the white of a raw egg.

Tem'po-ral. Pertaining to the temples.

Tet'a-nus. A disease marked by persistent contractions of all or some of

the voluntary muscles; those of the jaw are sometimes solely affected; it is then termed lockjaw.

Tis'sue. Any substance or texture in the body formed of various elements, such as cells, fibers, blood vessels, etc., interwoven with each other.

To-bac'co. A narcotic plant used for smoking and chewing, and in snuff.

Tox'in. A poison formed by bacteria in both living tissues and dead substances; a poisonous ptomaine.

Tu'ber-cle. A pimple, swelling, or tumor; the specific lesion produced by the tubercle bacillus.

Tu-ber'cu-lo'sis. An infectious disease due to the bacillus tuberculosis. The form of this disease with marked pulmonary symptoms is popularly known as *consumption*.

Tym'pa-num. The cavity of the middle ear, resembling a drum in being closed by two membranes.

U'vu-la. The small pendulous body at the middle of the soft palate.

Vac'cine vi'rus. The virus used in performing vaccination; now usually derived directly from the cow.

Var'i-cose. Distended or enlarged, as a vein.

Vas'cu-lar. Pertaining to or possessing blood or lymph vessels.

Ve'næ ca'væ. A name given to the two great veins which meet at the right auricle of the heart.

Ven'ti-la'tion. The process of replacing the foul or vitiated air in any room or confined space with air that is pure.

Ver'mi-form. Worm-shaped.

Vil'li. Minute threadlike projections upon the internal surface of the small intestine.

Vi'rus. The poison of an infectious disease, especially one found in the secretions or tissues of an individual or animal suffering from an infectious disease.

Vit're-ous. Having the appearance of glass; applied to the humor occupying the largest part of the cavity of the eyeball.

Vo'cal cords. Two elastic bands or transverse folds of the larynx.

X-rays, or **Roent'gen rays.** The peculiar ether rays or waves discovered by Roentgen in 1895. These rays penetrate substances like wood, the bodily tissues, and many other substances; extensively used in the diagnosis of surgical cases.

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